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ANTARCTIC SEALS.

By WILLIAM S. BRUCE,

Naturalist to the Antarctic Expedition, 1892–3.

AFTER a period of dormancy extending over more than half a century, the Antarctic is again being opened up to scientific investigation and to commerce. Scotland and Norway sent out five vessels last year, and Norway is again to the fore this year; New Zealand also is said to be eager to join the chase. It seems also likely that work of a more purely scientific nature will be undertaken in the Antarctic during the coming year. Some readers may, therefore, be interested to hear something about the southern seals, which differ very considerably from those of the north.

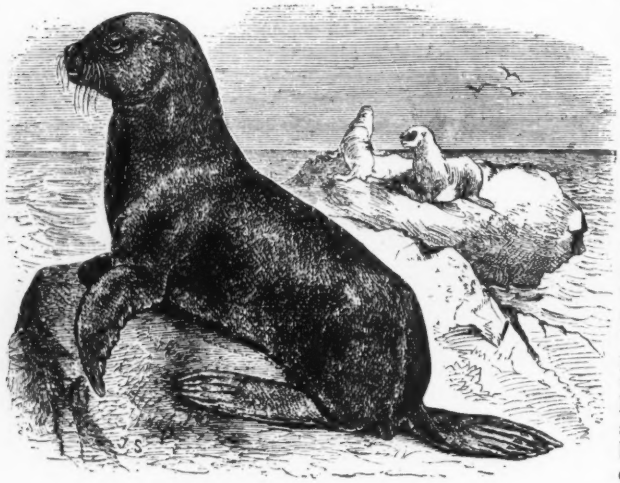
In the Antarctic only two of the great families of seals are represented: they are the sea-lions and sea-bears, or eared seals (*Otariidæ*), and the more specialized true seals (*Phocidæ*); the intermediate family of walruses (*Trichechidæ*) being entirely absent. In recognizing nine different species of *Otariidæ*, Mr. J. A. Allen divides the family into five species of sea-lions and four species of sea-bears, and three of these five sea-lions and three of the four sea-bears belong to southern seas. The true seals he divides into sixteen species, and five out of these sixteen species of true seals belong to southern seas. It is from the sea-bears of the *Otariidæ* family that ladies' sealskin jackets are made; the under skin, to which the long, rigid hairs are attached, is shaved off, and the long hairs fall out, leaving the upper skin with the soft under fur alone. The Falkland Islands' fur-seal (*Arctocephalus falklandicus*) is noted, however, for the evenness, shortness and elasticity of the fur. The fur is soft enough to wear as a rich fur without the removal of the longer hairs, which are always removed in the other fur-seals. The skins of all other seals, whether sea-lions or true seals, are used for making leather. The tens of thousands of seals that are slaughtered annually off Newfoundland and Greenland supply us with patent leather, and similarly the twenty to thirty thousand seals' hides that the Dundee whalers brought home from the Antarctic last spring will eventually be used for the same purpose. Crocodile leather, which we see in such vast quantities nowadays, is also said to be largely made from seals' skins. Besides skins, seals provide a great quantity of oil. During the recent trip to the south, the Dundee vessels secured from seven hundred to one thousand tons of seal oil; this is largely used in the jute manufactory for moistening the fibres, and this fact possibly accounts for Dundee not only being "Juteopolis" but also practically our only remaining sealing and whaling port. But now mineral oils, which are so cheap, are taking the place of animal oils in the jute factory as they have in other branches of industry, and the masters and owners of sealers and whalers are beginning to think it hardly worth while fishing seals and whales for oil alone.

Concerning the sea-bears, or fur-seals, and the sea-lions, or hair-seals, of the Antarctic very little is known. The former have an abundant soft, silky under fur, are black when young, and ultimately yellowish or whitish-grey colour; and the latter, the sea-lions, have no under fur, but only coarse, hard, stiff hair; they are yellowish or reddish-brown, dark when young, but become lighter as age advances. The groups generally live apart, but have the same geographical distribution. They are gregarious, polygamous, and the males are from three to five times as large as the females. They differ very markedly from true seals in having the power to turn their hind limbs forward, and thus use them for locomotion on land: the presence of a small external ear is another characteristic. Of the Alaskan seal herd, Mr. H. W. Elliott gives the following graphic description, which may be extended to the southern herds: "The fighting between the old males for the cows is mostly—or, rather, entirely—done with the mouth. The opponents seize one another with their teeth, and then, clenching their jaws, nothing but the sheer strength of the one, and the other tugging to escape, can shake them loose, and that effort invariably leaves an ugly wound, the sharp canines tearing out deep gutters in the skin and furrows in the blubber, or shredding the flippers into ribbon-strips.

"The bulls generally approach each other with comically averted heads, just as though they were ashamed of the rumpus which they are determined to precipitate. When they get near enough to reach one another, they enter upon the repetition of many feints or passes before either the one or the other takes the initiative by gripping. The heads are darted out and back as quick as a flash; their hoarse roaring and shrill piping whistle never cease, while their fat bodies writhe and swell with exertion and rage; furious lights gleam in their eyes; their hair flies off into the air, and their blood streams down. All this combined makes a picture so fierce and so strange that, from its unexpected position and its novelty, this is one of the most extraordinary brutal contests man can witness."

Mr. J. A. Allen has done much to simplify the classification, but the utmost confusion exists in most of the attempts made to classify them. Many attempt to divide them into a great many genera, but Mr. Beddard considers that if "the genus be split up at all it should be divided

into *Otaria*, containing only the Patagonian sea-lion (with its various synonyms) and *Arctocephalus*, comprising all the other species." The latter have narrower and more pointed noses and longer ears, besides other anatomical differences. The most notable is the Patagonian sea-lion (*Otaria jubata*), which is represented by a living specimen in the gardens of the Zoological Society. Besides inhabiting Patagonia and the coasts of South America, this remarkable animal is also found in the Falklands. As is well known to frequenters of the Zoological Gardens, this animal in captivity becomes remarkably tame, and even shows great affection to those who attend to its wants. The Cape sea-lion (*Otaria pusilla*) inhabits the islands south of Africa. A living representative of this species is also to be seen at the



The Patagonian Sea-Lion (*Otaria jubata*). From Sclater. *Proc. Zool. Soc.*, 1866, p. 80.

Society's gardens, its pond being close to that of the public favourite; it is smaller than the Patagonian sea-lion, and is less familiar to the public. The Australian seas have also a representative. Strictly speaking, perhaps one should exclude most of the *Otariidæ* from Antarctic fauna, but in a wide sense most of the localities above mentioned are spoken of as being within the sphere of the Antarctic regions. In places such as South Georgia, the South Shetlands, and the island of Mas-à-fuero, near Juan Fernandez, and other localities where these animals abounded, they now no longer exist, on account of the excessively greedy ravages of man.

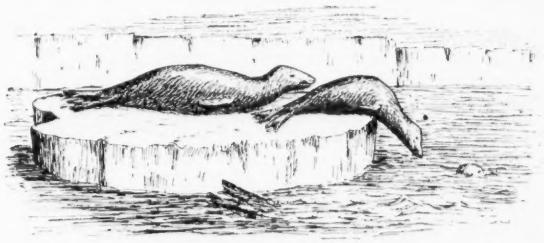
Formerly there was an extensive fur-seal trade in South America and the Falkland Islands, in Australia, and in South Africa; but now there are so few seals in these localities that they are not worth hunting. In the Falkland Islands, however, it is pleasing to hear that the fur-seals are now increasing in numbers, the most rigid protection being enforced; but with no telegraphic communication, and with no railways in the islands, poachers are said often to be able to secure a considerable amount of booty and make off before the authorities are able to enforce the law. In islands lying within New Zealand or Tasmanian waters a close season has also recently been proclaimed.

The true seals are represented by five species and two genera (*Allen*); they are the white Antartic seal (*Stenorhyncus carcinophaga*), sometimes called the "crab-eater seal" (for what reason it is difficult to say); the sea-leopard seal (*Stenorhyncus leptonyx*); Weddell's false sea-leopard seal (*Stenorhyncus Weddellii*); Ross's large-eyed seal (*Stenorhyncus Rossii*); and, lastly, the monster seal known as the "sea-elephant seal" (*Cystophora elephantina*). Skulls, and in some cases complete skeletons, of most of these seals are exhibited in the British Museum, South Kensington, and the College of Surgeons' museum, as well as in some of the provincial museums; one or two stuffed specimens also occur.

Of these five species the first two, the white Antarctic seal and the large sea-leopard, are most abundant, being found in great numbers on the pack ice. The beautiful white Antarctic seal must surely be a descendant of Rudyard Kipling's great white seal, which roamed the world around to escape cruel and relentless man. Its coat is of a beautiful creamy white, resembling that of the polar bear, but short-haired, the colour becoming somewhat more intense along the back. Looking at the animal face to face, its coat appears silvery, and the dorsal stripe almost vanishes; but when looked at from behind it assumes a deeper cream colour, and the broad stripe along the back becomes quite prominent. The full-grown animal may attain a length of about seven feet. The sea-leopard is a very striking animal, and, with the exception of the sea-elephant, is the largest of all seals. In the recent Antarctic expedition (1892—3) some were met with that measured over thirteen feet in length. Their coat is a dark brown-grey and mottled, becoming paler grey below, and in some cases almost black on the back. A rather striking and not altogether inappropriate name was given to these seals by the sailors in the recent cruise; they called them "serpents," and they do really often look very serpent-like with their long necks and green eyes. Weddell's false sea-leopard is more rarely met with, and is nearly as large as the sea-leopard, but less shapely and more thickly blubbered; its head is smaller, fore flippers very small, coat more woolly and of a dark brown-grey. Ross's large-eyed seal is a beautiful creature, with bright and affectionate eyes; in form and size it is very like the white seal, but its coat is of a beautiful mottled grey, darker towards the back. The sea-elephant is the largest of all seals, attaining the enormous length of twenty feet. It is a near relative of the crested seal of the north, and is also found along the Californian coast. The male has a somewhat elongated snout, hence the origin of its name. The females are about one-third less in size. The males are said to come ashore on the Shetlands about the end of August and beginning of September, and in the first part of October are followed by the females. The males are very fat when they first arrive, but get lean towards the end of December, when they leave the islands. Another herd was said to visit the islands about the middle of January—when they renew their hair—and still another in March; by the end of April all returning to the sea. They are very difficult to kill, but, like the other species, allow themselves to be approached even with a club. This seal used to be highly valued for its blubber; in 1821 and 1822 alone as much as nine hundred and forty tons of sea-elephant oil was taken from the South Shetlands; and it may here be mentioned that during these same two years at least three hundred and twenty thousand fur-seals were also taken from these islands.

It was with the skins and blubber of the first two species of these true seals that the Scottish and Norwegian crafts loaded themselves last season. The slaughter was revolting to one unused to it: within two minutes the seal is brained, deprived of its skin, and its gory corpse left writhing on the snow. Early in the morning, when the sun is beginning to make more or less impression by his rays, and the seals are coming out of the water on to the

pack, all hands are ready to take part in the fray. The sails are stowed; the skipper sits in the crow's nest from early in the morning till late in the evening; the two



Sea-Leopards on pack ice.

engineers, relieving one another, take charge of the engines; the cook or the steward is on the look-out; some non-combatant takes the helm; all the rest are away after plunder in the boats. Now a full boat is making its way to the ship. She steams towards it. As she nears, the engines are stopped and the boat glides alongside. The cook or the steward rushes from the look-out, the helmsman from the wheel, one working the steam winch and the other unswitching the skins, while the boat's crew swallow a hasty meal. Their boat being unloaded, they are off again for another fill. Another boat is seen approaching, and away the ship goes again, dodging this piece of ice, charging that piece with her sturdy bows, boring away where the ice lies closely packed, rounding this berg, and on to the next, until she reaches the boat, which is down to the gunwale in the water, with its crew cautious, plying their oars as they lie crouched upon their bloody load. So it goes on from day to day; "hay is made while the sun shines," and the pile of skins and blubber rises high upon the ship's deck. Then comes a gale of wind, accompanied by fog, sleet and snow, and the ship "lays to" under lee of a stream of pack ice or a berg. The deck becomes busy with life; the blubber is "made off," and put into the tanks, and the skins are salted. During such inclement weather the seals do not seek the ice, but may be seen swimming about in the water. When the gale is over, at the end of two or three days, the next few days of calm weather are again taken advantage of to continue the slaughter. Thus the periods of gales and calms, which alternate in this part of the world, come in conveniently for sealing: the produce obtained in the calm weather being "made off" during the gales.

Concerning the habits and anatomy of these seals much remains to be investigated. During the summer months (December, January, February), as has already been stated above, the first four are to be found on the pack ice, where, during the day, they bask in the sun, digesting the meal of the previous night. Their food consists of fish or shrimp-like crustaceans, and sometimes of penguins. Stones, which were probably first swallowed by the penguins, may also be found in their stomachs. They become so lazy with sleep that a man may dig them in the ribs with the muzzle of his gun, and wondering what it is disturbing their slumbers they raise their head, which quickly falls pierced with a bullet. There may only be one seal on a piece of ice, which is usually the case with the sea-leopard seals, but the smaller kinds lie in half-dozens and tens, and as many as forty-seven were seen on one piece during the recent cruise. On one occasion several seals were found upon a tilted berg; so high was the lowest edge above the surface of the water that the boat's crew with difficulty clambered up and secured their prey. Yet the seals must have made a leap from the water on to this their last resting-place. December seems to be their mating season; about that time they are in very poor condition, and very much scarred. The females appear to be as freely scarred as the males. It was also noted that the seals were most numerous where the water was bluest and clearest—this in all probability, meaning that they were more numerous on the outside of the pack, since the muddy olive-brown colour of the water, due to *corethron diatoms*, seen so frequently in the south polar seas, seems to indicate proximity to the main pack. The males appear to be as numerous as the females, and, in the case of the sea-leopard seal and Weddell's seal at least, the males are perhaps rather smaller than the females.

They move swiftly through the water, and can throw themselves eight or nine feet above the surface, covering distances of fully twenty feet. Their moaning in the gloaming of a calm grey day comes as a weird sound through the haze, and makes the icy solitude more lonely, adding awe to a scene already full of fascination! They seem to wonder at man, and not recognizing him as an enemy they allow him to approach, only to be laid low with club or bullet. It is a matter of great regret that they should be so indiscriminately massacred; there is no regard for sex or age, and even females heavy with young do not escape. If fleets of sealers continue to visit the south, there should be some law of protection, otherwise there is no doubt that, like the southern fur-seals at the beginning of the century, these Antarctic seals will be exterminated.

THE COFFIN OF THE BUILDER OF THE THIRD PYRAMID.

By F. W. READ.

THE coffin and bones of Menkaura, which stand near the entrance to the First Egyptian Room in the British Museum, have been for upwards of half a century exhibits of the greatest interest to students of the ancient world. They have recently, however, been invested with a new interest of quite another kind, by the supposed discovery of one of the younger generation of German Egyptologists. We are invited, in fact, to transfer the date of the coffin from the fourth to the twenty-sixth dynasty, a difference of from two thousand to three thousand years. But before entering upon an explanation of the new view, it may be well to give some slight account of the finding of these famous remains, and the opinions hitherto held in regard to them.

The three principal pyramids, which were built on a rocky plateau to the west of Memphis, are assigned by Herodotus to three successive monarchs named Cheops, Chephren, and Mykerinos. This is one of the few instances in which "the Father of History" seems to have lighted upon a genuine tradition. The building of those three gigantic pyramids marked an epoch in the history of the country, and must have profoundly impressed the imagination of the people; and this may perhaps account for the truth having reached the ignorant temple attendants from whom Herodotus appears to have derived his information. The three monarchs in question bore the native names of Khufu, Khafra, and Menkaura; and their succession is proved beyond doubt by the Egyptian monuments. First, by the inscriptions in certain tombs, which give us the names of the successive monarchs in whose reigns the occupants of the tombs lived. Secondly, by the lists of kings which the sovereigns of the new empire set up to the honour of their ancestors. The connection

of the monarchs with the pyramids is not very fully evidenced, as the walls of the chambers were left absolutely bare of inscriptions. But though there are no inscriptions, as ordinarily understood, the name of Khufu is found roughly scrawled on the walls of the so-called King's Chamber in the first pyramid. These, with various other scrawls, are supposed to be masons' marks, and may be accepted as sufficient evidence that the stones were hewn for the king whose name they bear. The third pyramid is connected with Menkaura by the coffin to be more particularly described later. It must also be remembered that the period during which the fourth, fifth, and sixth dynasties ruled was an age of pyramid building. This is amply evidenced by the fact that it was customary to write after the king's name that of his pyramid; and in this way it is established that Khufu, Khafra, and Menkaura did at least each build a pyramid, whether those ascribed to them by Herodotus or some others. Taking, then, all these facts together, each slight in itself, but the whole pointing to the same conclusion, we can hardly resist the inference that the story of Herodotus is a genuine Egyptian tradition.

But if we ask the date of the "Pyramid Kings," Herodotus is no longer a safe guide. He places the reigns of these monarchs almost immediately before that of Sabakos. This king, known to the monuments as Shabaka, was the founder of the twenty-fifth or Ethiopian dynasty, and the commencement of his reign may be fixed with a close approximation to the truth at B.C. 700. The whole of the available evidence, however, goes to show that the three chief pyramids were built during the fourth dynasty, the first of which any contemporary monuments exist. The date to be assigned to it has long been a matter of dispute. The chronology of Brugsch, which is accepted among Egyptologists generally as a convenient provisional scheme, fixes the reign of Khufu at B.C. 3733–3700. But there are many circumstances which render it excessively difficult to construct any satisfactory Egyptian chronology for the period prior to the expulsion of the Hyksos. The materials available are of three kinds: (1) the fragments of the historical work of Manetho; (2) certain lists of the old kings set up under the new empire; (3) contemporary monuments. A few words under each of these heads will enable the reader to understand generally the position of the question.

1. Manetho, who was a priest of Sebennytus in the Delta, wrote his history under the Ptolemies. It was written in Greek, and presumably for the information of the conquerors. This work, having been written while the hieroglyphics were still intelligible to educated Egyptians, and being doubtless based chiefly on authentic temple records, must have been a most valuable guide to the main current of Egyptian history. Unfortunately for us, the original work has perished; there remain only distorted and mutilated fragments, a mere skeleton of names and figures from which the flesh has been ruthlessly torn. These bare catalogues of kings were drawn up by Africanus in the second, and by Eusebius in the fourth, century of our era. They also were destined to disappear, their only representatives at the present time being an Armenian version of Eusebius and the "Chronography" of George the Syncellus (about A.D. 800), which embodies the lists of both Africanus and Eusebius. A solitary quotation in Josephus, describing the Hyksos invasion, alone survives to tell us that the original Manetho was very different from that handed down by the epitomists. The lists, moreover, are hopelessly at variance in the lengths of the reigns assigned to the kings, and in several cases the evidence of the monuments shows them to be false. To a very large extent, however, Manetho has been vindicated. In particular, the rule of the Hyksos conquerors, once doubted by Egyptologists, has been established by the gradual accumulation of a number of small fragments of evidence, the combined force of which is too great to be resisted. Still, the correctness of the lists is so far doubtful that no satisfactory chronology can be founded upon them.

2. Under the eighteenth and nineteenth dynasties (about B.C. 1700-1200) various lists of kings were set up in the temples and elsewhere. Their object was not historical but devotional; they belonged to that ancestor worship which was so important a part of the Egyptian religion. Hence it was not considered necessary to mention *every* king who had reigned, and no dates or lengths of reigns were inserted. The result is that the various lists differ greatly among themselves. The longest one, that of Seti I., at Abydos, shows seventy-five kings as having preceded him on the throne of Egypt. Yet even this list omits many whose reigns have been fully established by the monuments. Besides a number of others, it passes over all the kings between the twelfth and eighteenth dynasties, *i.e.*, not only the whole of the Hyksos rulers, who would certainly not be reckoned as ancestors by the race that had driven them from the throne, but at least one dynasty of native kings. So that these lists, useful as they are, can no more than Manetho give us an exact chronology.

3. Contemporary records are necessarily our most valuable material, and it is from them that modern Egyptologists have chiefly written the history of Ancient Egypt; but they are not sufficient for the construction of a chronology. They are mainly of two kinds: inscriptions made by order of the kings in commemoration of their exploits (these being chiefly found on the walls of temples), and those inscribed in the tombs of private persons. These latter are of special value in indicating the successive monarchs under whom the deceased and sometimes his ancestors served. They also frequently tell us of the great works, whether of peace or of war, in which he was engaged. These two classes of monuments taken together would afford a nearly perfect chronological system, had we a complete series of them. But in early Egyptian history there are several "dark periods," for which no contemporary monuments whatever have been found. Such portions of the history we only know from the Manethonian and monumental lists. But even if we had a series of contemporary monuments embracing every portion of the history, this would not make our chronology exact. If we find the thirtieth year of a king mentioned, we know that he must have reigned *at least* twenty-nine years, but we have no means of knowing how much longer he may have reigned. It so happens, however, that for the latest period of Egyptian history we have a series of monuments which not only fix the succession of the kings but the exact lengths of their reigns. These are the well-known Apis tablets. The bull Apis or Hapi was worshipped at Memphis from very early times as an incarnation of the god Ptah, the principal deity of the city. When one of the bulls died he was buried in a most magnificent manner in a specially-constructed vault, and tablets were set up to his memory. These tablets stated the date of his birth, of his enthronement at Memphis, and of his death; and, as all dates in Egypt were expressed in the regnal years of the monarch, it is plain that we have here a means of determining the lengths of the reigns of the kings mentioned. These tablets extend from the reign of Taharka (of the twenty-fifth dynasty) to the time of the Ptolemies, so that from about B.C. 700 we have a chronology which cannot vary more than four or five years from the truth.

XUM

Briefly, then, these are the materials from which Brugsch constructed his chronology. He accepted the great tablet of Abydos as affording the best list of kings for the period prior to Seti I.; assumed that on the average three kings would reign one hundred years; and allowed some five hundred years for the period between the twelfth and eighteenth dynasties, which the tablet of Abydos ignores. For the next period, *i.e.*, from Seti I. to the twenty-fifth dynasty, he gathered the succession from contemporary monuments, still counting three kings to the century; and thenceforward he adopted the absolute dates fixed by the Apis tablets. It is obvious, therefore, that the dates given by Brugsch for the earliest period (to which the "Pyramid Kings" belong) leave room for some error. This, however, could hardly amount to more than five hundred years, and even if we allow one thousand years, the "Pyramid Kings" may still claim an antiquity in comparison with which the earliest periods of Greek and Roman history appear modern.

Having now established, as far as the materials will allow, the kings to whose reigns the pyramids are to be assigned, and the place of those monarchs in the history of Egypt, we may pass to an account of the discovery of the coffin and sarcophagus of Menkaura, and finally to a consideration of the recent attack upon the authenticity of the former. In the year 1837 Colonel Howard Vyse made a thorough examination of the pyramids, and was fortunate enough to discover in the third a very beautiful basalt sarcophagus, a wooden coffin, and portions of a human body. If these latter are the remains of the original occupant of the coffin, they are of surpassing interest, as the oldest historical remnant of the body of a human being extant. There have not been wanting those who have denied their title to this description, and have supposed them to belong to some prowling Arab. There are two circumstances, however, which render such a view wholly untenable. Portions of the coffin and mummy were found together in a chamber adjoining that which contained the sarcophagus. It would appear that the Arabs had at some unknown period broken into the pyramid for purposes of plunder (as is their habit), and that, having taken the coffin and its contents out of the sarcophagus, they removed them to a larger chamber for more convenient examination. Here they broke open the coffin, and tore the mummy to pieces in their search for valuables. It does not seem otherwise possible to account for the fragments of the body and the coffin being so intimately associated. Another circumstance, apparently very little known, which was brought to the notice of the writer by a medical man, points in the same direction. The person whose remains were found in the pyramid suffered from anchylosis of the knee, and it is in the last degree unlikely that anyone with such a complaint would attempt to clamber about in a pyramid.

The sarcophagus, coffin, and mummy were shipped for conveyance to England, but the vessel was unfortunately wrecked off Gibraltar. The sarcophagus, owing to its weight, was lost beyond all hope of recovery; but a considerable portion of the mummy, and nearly the whole of the lid of the coffin were saved, and ultimately deposited in the British Museum. It is on this lid that the inscription occurs which leads us to assign the third pyramid to the reign of Menkaura. It runs as follows:—"Osiris, King of the North and South, Menkaura, living for ever! Heaven has produced thee; thou wast conceived by Nut; thou comest of the race of the god Seb. Thy mother Nut spreads herself over thee in her form of heavenly mystery. She grants that thou shalt be a god; never more shalt thou have enemies, O Menkaura, King of North and South, living for ever!" (*Guide to the British Museum*, p. 102.) On the faith of this inscription, the coffin has been hitherto almost universally accepted as that in which the bones of Menkaura originally reposed. Egyptology, however, is no more than other sciences exempt from destructive criticism; and at last a man has arisen bold enough to dispute the antiquity of this cherished relic. In the *Zeitschrift für Ägyptische Sprache* of Leipzig there has recently appeared an article by Herr Kurt Sethe, in which he contends, chiefly on philological grounds, that the coffin must be assigned to the twenty-sixth dynasty. The argument cannot be fully explained without the use of hieroglyphics, but an attempt may be made to indicate its general character.

Let us take, for example, the first word of the inscription, "Osiris." This word, as written here, and commonly elsewhere, consists of three characters—a seat, an eye, and a bearded human figure. The seat and eye are phonetic, being pronounced respectively *uas* and *ar*, making together Uasar, which the Greeks converted into Osiris. The bearded human figure is ideographic, and shows that the preceding signs constitute the name of a god. Now it is a singular fact, and quite contrary to what one would expect, that the early texts are very deficient in these ideographic signs, and this is markedly the case in the name of Osiris. Herr Sethe states that it cannot be found with such a sign till the middle of the fifth dynasty. This will serve as a sample of the argument, similar reasoning being applied to nearly every word in the inscription. Herr Sethe, however, does not deny that the third pyramid was built for Menkaura, or that he was buried in it. Taking his stand on the admitted fact that under the twenty-sixth dynasty there was a perfect rage for everything belonging to the fourth dynasty, he suggests that it was thought right to examine the tombs of those early kings and "restore" whatever was defective. Finding the coffin of Menkaura sadly decayed they made him a new one, putting on it the old inscription. This they wrote, not in the archaic manner, but as it was customarily written at the time. The conclusion is not so startling as if the coffin had been declared to be an out-and-out forgery; still, it is sufficiently striking to arouse the interest of all lovers of antiquity. A difference of from two thousand to three thousand years is not one to be lightly passed over.

The object of this article being simply to state a curious Egyptological problem in such a form that the non-Egyptologist can readily grasp the point at issue, it is beyond its scope to enter upon either an attack or defence of the new view. This will be an easier task when the "heresy" has been examined by the leaders of Egyptological thought.*

CURIOUS COCOONS.—II.

By E. A. BUTLER.

WHEN once a moth has escaped from its cocoon there is generally no further use for the deserted shelter, and it is left to take its chance of wind and weather. But in one or two instances, at least, this rule does not hold good, and the vacated cocoon still serves a useful purpose in the economy of the insect. The vapourer moth (*Orgyia antiqua*), whose

* In his recently-published work on "The Mummy," Dr. Budge seems to rest the case for the antiquity of the coffin on the appearance of the wood (p. 208). It would be interesting to know how he distinguishes wood 5500 years old from that which is 3000 years younger. It is right to state that Dr. Budge is here replying to some obscure French writer, having been apparently unacquainted with Herr Sethe's more formidable attack. In a later portion of his work (p. 306), he mentions the latter's article, but without offering an opinion on the question at issue.

curiously tufted and tussocked caterpillar we alluded to on a former occasion, employs its old cocoon as a receptacle, or rather support, for its eggs. In every part of its economy this insect is an odd creature. It is one of those few Lepidoptera the females of which are practically wingless. The male insect is a lover of bright sunshine, and flies in search of its apterous and stay-at-home mate during the hottest parts of summer days. As it is an exceedingly common insect, and the caterpillar feeds upon a variety of shrubs which are amongst those cultivated by man, it makes itself quite at home in the gardens and squares of our large towns, and may often be observed gaily fluttering along the streets in the neighbourhood of its home. It is a modest little broad-winged, russet-coloured insect, with a crescent-shaped spot of white towards the outer and lower corner of each fore-wing, and with beautiful comb-like antennæ. Its partner does not rely upon beauty as a recommendation, for she is one of the plainest-looking creatures imaginable, and it requires a stretch of charity to refrain from calling her positively ugly. She possesses the merest rudiments of wings, though, as she never uses them, she might as well have none at all. Her figure exhibits an excess of obesity which, to the human eye at least, is sufficiently repulsive, but apparently it has its attractions for her own kind, for the males will come long distances for the honour of becoming the possessors of her unwieldly frame. Her body is clothed with a thick covering of pale greyish hairs. She never leaves the cocoon which was the home of her pupahood, but waits upon it till the arrival of her accepted swain, after which she lays her eggs, scattering them over the surface of the cocoon, the greater part of which they are generally numerous enough to cover. This done, she dies.

The cocoon is loosely constructed; the silk is fine and glossy, but as many of the caterpillar's hairs are intermingled with it, the texture appears coarse and irregular, and the black brush-like hairs that belonged to the tufts at the sides of the neck and at the tail are sometimes conspicuous objects amongst the otherwise pale yellowish mass (Fig. 5). The cocoon is not a complete one, like most of those described in our last paper, but should rather be described as simply a web forming a roof arching over the chrysalis, the surface of a tree trunk or wall constituting the base of support, and occupying the whole of the other side. The chrysalis is of a deep brown colour, and, strange to say, is ornamented with tufts of hairs on its different segments, a feature which is, however, characteristic of the family. The scattering of the eggs over the web may, perhaps, in some way be connected with the unusual circumstance that the eggs do not all hatch at the same time, but the young caterpillars continue to issue from them during a period of ten weeks, so that eggs, caterpillars, pupæ, and perfect insects may all be met with at the same time during the summer. Another species, called the scarce vapourer moth (*Orgyia gonostigma*), a much less common insect, has similar habits.

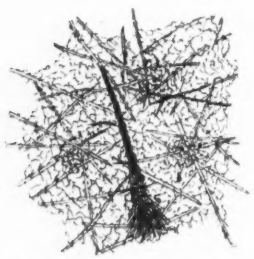


Fig. 5.—Part of Cocoon of Vapourer Moth, showing one of the black brush-like hairs. Magnified six diameters.

It may be taken for granted that hairy caterpillars will, as a rule, intermix their hairs with their silk, thereby effecting a considerable saving of material; but this is not very different from saying that cocoons may generally be expected to contain hairs, for it is chiefly, though not exclusively, hairy caterpillars that make cocoons, and the longer and more numerous the hairs with which the caterpillar is clothed, the larger will be the proportion they will bear to the silk in the construction of the cocoon. This is very manifest in the slight web formed by the garden tiger moth (*Arctia Caja*), whose caterpillar, popularly known as the "woolly bear," is the hairiest of a hairy family. The web is thin, and the dark hairs are extremely conspicuous. This is also true of the rest of the "tigers," belonging to the same genus, and of the "ermines," belonging to the genus *Spilosoma*, and the colour of the cocoon is, therefore, obviously determined largely by that of the caterpillar's hairs. Now it is clear that if an attempt were made to utilize the silk of such cocoons, the numerous hairs scattered amongst and clinging to the threads would become a serious inconvenience in the unwinding of the silk, even should the threads of the latter be sufficiently continuous to make such a procedure possible. It is fortunate, therefore, that the silkworm of commerce is not a hairy insect, for if it were, it would assuredly mingle its hairs with its silk, and thus render its cocoon useless for manufacturing purposes. The fact that it is hairy when first hatched, though it loses its hairs almost entirely at the first moult, seems to point either to an original adult hairiness when in a wild condition, or at least to its descent from hairy ancestors. As the present excellence of the silk is, no doubt, due to long domestication and careful selection, it is quite possible that a reversion to hairiness of body in the adult condition would be accompanied by a deterioration in the quality of the silk itself, quite apart from what would result from the admixture of hairs.

Amongst other curious lepidopterous cocoons may be mentioned that of the lackey moth (*Clisiocampa neustria*), yellowish white, and supplied, when first formed, with abundance of a pale yellow powder like flowers of sulphur; this is at first scattered through the silk, but gradually collects into the lowest corner, and soon after falls out altogether through the meshes. The two beautiful moths called "green silver lines" (*Halias*), whose fore-wings are of a delicate pale green with two or three white or yellowish lines drawn across them, make cocoons which are like an inverted boat. Passing to exotic insects, we find some very curious cocoons amongst the silk-producing Bombyces; one of the most extraordinary is that of the tusser silk moth. This is a large moth of a pale fawn colour, with transparent circular windows in the centre of its wings; it is a good deal reared in India for the sake of the silk obtained from its cocoon. The cocoon is oval, hard, and compact, without loose outlying threads, seeing that it is not anchored as usual, but is suspended at the end of a stout stalk, the further end of which forms a circular loop tightly fastened round some twig of the food-plant, so that the cocoon hangs from the bough like a kind of fruit (Fig. 6).

Fig. 6.—Cocoon of Tusser Silk Moth.

Our next illustrations will be taken from the order

Coleoptera, or beetles. Many of these insects feed upon plants, and amongst these vegetarian groups are several species that construct cocoons. Two of the most interesting instances may be mentioned, both taken from the beetles called weevils. A weevil may be easily recognized by the peculiar structure of its face; this is prolonged into a longer or shorter beak or snout, sometimes reminding one of an elephant's trunk, and carrying the mouth organs at the tip. *Hypera variabilis* is the name given to a brownish species which feeds upon various leguminous plants, and, while generally common, is sometimes found in absolute profusion. The grub of this creature, a short caterpillar-like being, covers its body with a sticky substance secreted by a gland placed at the tail. When it has eaten its destined amount of lucerne or other leguminous food, and reached its full size, it retires to the underside of a leaf, and begins to construct there, with this same sticky substance, a kind of oval cage consisting of a thin and open network of threads. Within this the little creature enters upon its pupal experience, remaining, of course, still visible from the outside through the meshes of the network. Few natural objects are more graceful and delicate than these little cages, which may often be seen attached to leaves. The construction of the cage is rather a slow business, occupying, although it is not a large structure and the network is but one layer thick, about twenty-four hours in completion. So delicate a structure would, no doubt, stand but little wear and tear, and would be a most imperfect shelter against climatic changes; but fortunately its durability is not greatly put to the test, for the perfect beetle is rapidly developed within, and issues after only a few days of captivity. The genus *Hypera* is a large one, containing sixteen British species, the habits of all of which are similar to those detailed above.

The other instance of beetle cocoons is that of the genus *Cionus*. Here we have half a dozen species of extremely pretty weevils, with large globular bodies, variously coloured, and always adorned with raised velvety patches, some of which are rectangular streaks and others circular discs. These beetles are specially attached to one order of plants, the *Scrophulariaceæ*, and particularly to those members of it called figworts (*Scrophularia*). The figworts grow in damp places in tall clusters; they may be known by their disagreeable odour, their succulent stems carrying opposite pairs of smooth, broad, rounded leaves with notched edges, and their bunches of small, deep red, cup-shaped flowers at the top. The flowers do not all open at the same time, so that often there may be seen on the same cluster buds, flowers, and seed-vessels. Sometimes the leaves of these plants are seen to be riddled with holes, as though someone had been making them a target for the discharge of small shot; the leaves are then more or less dry and brown. This damage is wrought by the larvæ of weevils belonging to the genus *Cionus*, and a little close inspection will usually reveal the beetles crouching down on the leaves; or failing this, if the eye be carried to the bunch of flowers, buds, and seed-vessels at the top of the stem, a still more careful scrutiny will probably detect a number of oval olive-brown bodies amongst the rounded buds and seed-vessels, and very closely resembling them in appearance (Fig. 7). These are the cocoons of the beetles, and though perfectly exposed, they are yet beautifully concealed by their resemblance to the fruitage of the plant. In many respects the economy of these insects is like that of the genus *Hypera;* there is the same sticky secretion on the larvæ, furnished by a gland at the tail, and as before it is worked up into an oval cocoon to enclose the pupa. But there is this difference: whereas the cocoon of *Hypera* is a network, that of *Cionus* is a continuous papery layer without openings, so that the chrysalis is entirely hidden. The structure, in fact, reminds one of a child's air ball, and within it the chrysalis lies free, rattling against the sides when shaken. Within its balloon-like covering the insect lies for about a week, when it casts its last skin, cuts nearly off a neat segment from the bottom of the cocoon, and crawls out through the hole. From the above it will be seen that these beetle cocoons are not strictly comparable with those of moths, inasmuch as the material of which they are composed is secreted, not by a gland opening beneath the mouth, but by one which opens upon the upper surface of the last segment of the body.

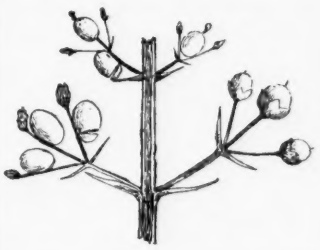


FIG. 7.—Part of Figwort Flower-head, with seed-vessels and cocoons of *Cionus scrophulariæ*.

A third order of insects, the Hymenoptera, now claims our attention, for the habit of cocoon-forming is widely extended, and occurs amongst most of the groups of insects whose metamorphosis is complete. Our illustrations will be taken from the parasitic members of this extensive order, which go by the general name of ichneumon flies. They are long-legged, thin-bodied, four-winged insects, with long antennæ and very often with the body terminating in a longer or shorter stick-like ovipositor. Most of them are during their larvahood internal parasites of other insects, their footless maggots living inside the bodies of caterpillars and other larvæ, and subsisting at the expense of the tissues of their hosts, whose ruin they thus achieve. Of these creatures, two extensive and well-defined families are recognized—the *Ichneumonidæ* and the *Braconidæ*. These two groups are very similar in general appearance, and certain members of the one family closely mimic certain of the other, so that a novice who did not know exactly what points to look for in endeavouring to distinguish them, would probably consider as identical two insects that would be in reality widely different, as would at once become evident if their whole life-histories could be simultaneously passed in review. But they may very easily be distinguished by paying attention to the arrangement of the nervures of the fore-wings. A comparison of the two wings in Fig. 8 will at once make this plain. In both there is a dark spot, called the "stigma," more than half-way along the upper margin of the wing; in the Ichneumonid the space immediately beneath this forms a large cell of a more or less distinctly five-sided outline and with its lower and outer edge concave; in the Braconid the same space is occupied by three cells, each roughly four-sided. The little nervure marked *n* also is present in the one and absent in the other. There is endless diversity in the actual forms of these cells in the different genera, but the general plan remains much the

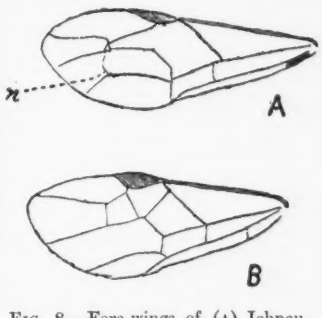


FIG. 8.—Fore-wings of (A) Ichneumonid, (B) Braconid.

same, and will usually serve to distinguish a Braconid from an Ichneumonid pretty readily.

Both of these groups of parasites make cocoons, many of which closely resemble those of the Lepidoptera, except that they are, most of them, smaller. But as the larvæ are naked maggots instead of hairy caterpillars, of course the cocoons are always composed purely of silk, and contain no hairs. As might be expected from the shape of the perfect insects, the cocoons are of a long, narrow form, equally rounded at each end; they are of all shades of colour, from the purest white to the deepest black. A large reddish-yellow Ichneumonid, *Paniscus testaceus* by name, which is very destructive to the puss moth, makes a thick, rough, dull blackish-brown cocoon. Except by those who rear the hosts, these cocoons are not likely to be seen, as they are to be found only inside the cocoon of the moth; for the parasite does not reach maturity till after its host has immured itself. Another ichneumon, strikingly like the last, and easily mistaken for it, though belonging to a different genus (*Ophion*), makes a totally different cocoon; it is much like those of the egger moths, only narrower—oval, yellowish-brown, and covered with a network of black threads. A species of Braconid (*Zele testaceator*), exceedingly like this again, though much less common, provides for itself a most elegant envelope of a satiny white appearance. Thus we have three species which superficially bear a close resemblance to one another, but which construct totally different cocoons. Some of the smaller kinds make very pretty cocoons; a little Ichneumonid parasitic on the weevil (*Hypera variabilis*), above described, makes a minute reddish-brown one with a neat white band round the middle (Fig. 9), and many others are similarly adorned.

FIG. 9.—Banded and tailed Cocoons of Ichneumon Flies.

Many of these cocoons may be found amongst the herbage in woods, hedges, &c., though their small size of course necessitates a careful search; after the disclosure of the flies, they appear to last for some months, and may be found lying about amongst dead leaves and other rubbish.

Amongst Braconids, there is a large number of small species which are great scourges to the caterpillars of moths and butterflies; they live gregariously in their hosts, and when full fed they eat their way out, and construct their neat little white, buff, or yellow cocoons in clusters round and over the shrivelled remains of their victim. The caterpillar of the common white butterfly (*Pieris rapæ*) may often be seen on walls, treated in this way, its crumpled and distorted carcase being almost hidden under a cluster of little oval silken spindles. One curious genus makes glossy brown cocoons, from one end of which a long, stout, and much-twisted anchoring thread proceeds, to the extent of some three or four times the length of the cocoon (Fig. 9); the method of its formation is not easy to understand. Some gregarious Braconids unite their cocoons together, deeply imbedding them in a common mass of silk which entirely conceals their outlines, and makes the whole look more like a single cocoon of a moderate-sized moth than a cluster of small ones. The possibility of such an association, of course, depends upon their all reaching the pupating stage at the same time; but there is no difficulty about this, for the eggs are all deposited in the host's body on the same occasion, and as the maggots are always completely surrounded by their food, the juices and tissues of their host, they all have equal chances of development, and therefore reach maturity together. The flies also emerge in company.

Science Notes.

Plate II. in the October number of KNOWLEDGE was made from a photograph of the photosphere taken by Dr. J. Janssen on the 10th of June, 1890. The sun's disc would have a diameter of 90 centimetres, or rather more than 35 inches on the scale of the plate.

De Morgan, in an interesting article in the *Philosophical Magazine* for April, 1848, on Thos. Wright "of Durham," attempts to show that Wright, whose theories of the Milky Way and Saturn's ring have recently attracted fresh attention, passed the greater part of his life in London, and not in the north of England. Amongst other proofs that Wright lived in London, De Morgan points out that he illustrated the dimensions of the solar system by comparisons with distances in the metropolis. Mr. R. A. Gregory has recently made a much more extended comparison of the same kind. He says: "If the dome of St. Paul's Cathedral is taken to represent the sun, Mercury is proportionately represented by a skittle-ball at Chancery Lane; Venus, by a globe rather less than one foot in diameter revolving at the distance of Charing Cross from the Cathedral dome; the earth, by a one-foot globe situated at Buckingham Palace; and the moon, a cricket ball circling round her at a distance of thirty feet. The radius of the orbit of Mars is represented by the distance from St. Paul's to South Kensington Museum, the planet itself being about the size of a small football. The minor planets are exemplified by small shot revolving at the distance of Hammersmith; Jupiter, by a globe eleven feet in diameter just beyond Richmond; Saturn, a nine-foot globe at Staines; Uranus, a four-foot globe at Reading; and Neptune, by a globe four and a half feet in diameter at Oxford. On this scale the nearest star has a distance of five hundred thousand miles.

Prof. Michelson's "Interference Refractometer," described in a recent number of *Astronomy and Astro-Physics*, is likely to prove of great use to spectroscopists. Among some twenty lines in the solar spectrum examined by it (though all appear to be simple lines when examined by the eye), the great majority proved to be highly complex. Thus, the red hydrogen line is a double, whose components have the intensity ratio seven to ten, and whose distance is about one-fiftieth of the interval between the sodium lines. Each component of the yellow sodium lines is a double, whose components have also the intensity ratio seven to ten, and whose distance apart is about one-hundredth of the distance between the principal components. Thallium gives a double line, whose components are in the ratio one to two, at a distance of about one-fiftieth of that of the sodium lines; while each component has a small companion, whose intensity is about one-fifth of that of the principal lines, at a distance of about one three-hundredth of that of the sodium lines. The green mercury line is made up of a group of five or six lines, the strongest of which is itself double (or perhaps triple), the distance of the components being less than one five-hundredth part of that between the sodium lines. These distances, small as they are, says Prof. Michelson, can be measured within about one-twentieth part, so that by this means it is possible to detect a change of wave-length corresponding to the ten-thousandth part of that between the two sodium lines.

SHOOTING STARS AND THEIR TRAILS.

By A. C. RANYARD.

ON any clear moonless night one never need wait many minutes to observe a meteor darting across the sky. Those most frequently seen appear and disappear almost before the eye has had time to note their colour and the direction of their motion; but occasionally larger meteors are observed which generally move more slowly across the heavens, and sometimes leave a luminous streak in their wake.

Prof. Max Wolf, of Heidelberg, has on several occasions succeeded in obtaining photographic traces of meteors which have appeared to the eye as large as stars of the first or second magnitude. The photograph which he has kindly sent for reproduction in this month's number of KNOWLEDGE shows two of such meteor tracks. They cannot both belong to the same meteor family, for their paths cross, and they therefore cannot have diverged from a common radiant area, as all meteors travelling parallel to one another in space appear to do.

The rich groups of meteors which the earth encounters at various times in the year do not appear to diverge accurately from a point in the heavens. Eye observations have shown that they diverge from a radiant region of sensible area; for though the meteors are, no doubt, moving absolutely parallel to one another before they meet the earth, they are slightly deflected from their original course after entering the earth's atmosphere, probably by reason of the irregular shapes of many of the meteoric masses, which causes them to skid on one side, as a stone or shell thrown into the sea is deflected by the resistance of the water. Sometimes meteor paths show a very sensible curvature, but in the case of eye observations there is always some difficulty in accurately noting small deviations from straightness.

Prof. Max Wolf's photographs enable us to detect the curvature of meteor paths with great precision. If a straight-edge be put against the smaller meteor track on our plate, viz., that which passes horizontally across the page, it will be seen that the path is decidedly convex towards the north, an effect which cannot be due to the distortion of the lens with which the photograph was taken; for, as will be seen by the distorted images of the stars which lie on the southern and eastern sides of our plate, it is an enlargement from only a part of the original negative, and the centre of the original negative was somewhere towards the top right-hand corner of our plate, where the images of the stars are round. Consequently, any distortion caused by the short-focussed photographic lens, with which the original negative was taken, would have given a still greater curvature to the other meteor track which passes diagonally across the page. The lenses which have been used for enlarging the picture had much longer foci, and the distortion caused by them may be neglected.

The meteor which has passed horizontally across the plate has drawn a clear sharp line of even thickness from side to side of the picture; but the larger meteor, which transited the field diagonally, has left a photographic trace which is decidedly thicker in some parts than in others, an appearance which was probably caused by differences of brightness at different parts of its path. The track of this larger meteor, when examined by a lens, is seen to break up, in some parts of its course, into knots or nuclei, separated by small intervals, as if the variations of brightness were very rapid.

It is difficult to conceive of such rapid alterations in the brightness in an ordinary incandescent solid such as we are able to experiment upon in the laboratory, but in the case of a meteorite we have a cold body with an incandescent skin or film of boiling material on its surface, for the meteor has just arrived from the cold of space and is being heated by the vigorous bombardment of its surface. The sudden expansion of the surface material, or of the skin beneath the boiling film, must give rise to fierce strains, which, in the case of a large bolide, sometimes rend it with a fearful noise like loud thunder, which has been heard for a distance of fifty miles, although the explosion or rending of the stone has taken place in the thin upper air.

Probably under no other conditions is a stone subjected to such fierce strains as when it plunges with planetary velocity into an atmosphere and is rapidly heated from its outside. No doubt, a soft stone would quickly crumble to pieces on being subjected to such an ordeal, and with every fragment detached the surface of the moving mass would be increased, and the area of incandescent surface, and consequently the brightness of the meteor would be proportionately increased.

The uneven photographic trail of this little meteor tells an eloquent tale as to the rapidity with which the crumbling fragments from the moving mass are driven into vapour and lost to sight. In the case of larger meteors the moving body is sometimes surrounded by an envelope of incandescent vapour, many hundred yards, and sometimes several miles, in diameter. Thus a remarkable fire-ball, which was well observed in the south-west of England on the 6th of November, 1869, was during its passage through the air surrounded by a luminous cloud more than four miles in diameter. It first became visible in the air at a point about ninety miles vertically above Frome, in Somersetshire, and disappeared at a height of about twenty-seven miles above the sea near St. Ives, in Cornwall, having travelled a distance of one hundred and seventy miles in about five seconds, with an average velocity of about thirty-four miles a second. This meteor was entirely driven into vapour, and after the fire-ball had disappeared a luminous streak or cloud about fifty miles long and four miles in breadth remained visible against the sky for some fifty minutes.

The heat developed at the surface of a body moving through a gas is proportional to the square of the velocity of motion. A body moving with a velocity of about a mile a second would have its surface raised to a temperature of about red heat, and with a velocity of only ten miles a second the surface of the moving body would be raised to a temperature of white incandescence far above that necessary to melt and vaporize all known substances. As Prof. Young has remarked, the temperature of the surface of a moving body *is independent of the density of the air* through which it is moving; but the velocity lost and the quantity of heat developed in a given time is, of course, greater where the air is dense, and the quantity of air which strikes the surface of the moving body, and is rendered incandescent by the motion imparted to it, evidently increases with the density of the air through which the moving body is rushing.

It follows from this reasoning that the surface of a meteorite must be raised to its highest incandescence immediately it plunges into the thinnest layers of the upper atmosphere; but certainly, as a general rule, meteors increase in brightness the deeper they plunge into the earth's atmosphere. We are therefore forced to conclude that the light given by meteors is chiefly derived from the incandescent air and vapours surrounding them, and not from the incandescent surface of the solid mass, or the liquid film surrounding it, which is so rapidly boiling

away or being driven into vapour. A similar conclusion is also forced upon us by the fact that the larger meteors, though seen from a distance of eighty or one hundred miles, present a sensible diameter. They are frequently described as presenting a pear-shaped disc of half the diameter of the moon, and indeed many of the small meteoric masses which have been seen to fall have been described by observers at a distance as presenting a disc of greater diameter than the moon, though the meteorite itself would have appeared as a hardly visible speck, without sensible diameter, at the distances from which the fall has been observed.

How, then, can the breaking up of a meteorite, and the sudden exposure of a larger surface to molecular bombardment, cause it suddenly to increase in brightness? It is evident that the rate at which the energy of the moving mass is dissipated in the form of heat and light will depend on the amount of surface exposed to bombardment, and the smaller the fragments which are broken away the larger proportion of surface relatively to their mass will they present for bombardment; so that the smaller the fragments the more rapidly will they lose their energy of translation, and the more rapidly will they be driven into vapour, and the greater will be the intensity of the light radiated at a given instant.

Our photograph seems to prove that the vapour generated only retains its brilliant incandescence for a small fraction of a second, for by the blow of the meteor, the incandescent air, as well as the vapour generated, must have attained a rapid velocity in the same direction as the meteor; and if it remained incandescent for an appreciable fraction of a second, its photographic trace would be reduced to a uniform streak.

The facts disclosed by meteors seem sufficient answer to the query whether gaseous incandescence can be produced by the application of heat, though it is probable that electrical energy is developed during the rapid evaporation of the liquefied material of meteors. It is evident that the greater part of the light radiated is due to gaseous radiation which is consequent upon the rapid transformation of molar energy, that is, the energy of translation of the meteor, into the forms of molecular energy which are usually described as heat and heat effects.

Our second plate shows the interior of Dr. Max Wolf's Observatory at Heidelberg, with the little equatorial telescope and attached cameras with which he has obtained such valuable results.

THE SOLAR FACULÆ.

By Monsieur H. Deslandres, *of the Paris Observatory.*

J'AI lu récemment et avec le plus vif intérêt l'article de Miss Clerke, "The Sun as a bright-line Star," publié dans votre numéro du mois d'Août. Les nombreux ouvrages de Miss Clerke sont très appréciés en France, et j'ai admiré une fois de plus cet esprit philosophique qui saisit si bien les grandes lignes des questions et les lieus généraux des phénomènes. J'ai suivi avec un intérêt égal la discussion ultérieure, à laquelle ont pris part MM. Ranyard, Maunder, Hale, Evershed, qui tous ont une grande autorité dans les questions spectroscopiques.

J'accepte volontiers l'offre que vous me faites de donner à mon tour, dans la discussion pendante, mon opinion personnelle, d'autant plus qu'elle paraît différer sur certains points des opinions déjà émises. En premier lieu, je désire appeler l'attention sur une confusion des faits et des mots qui a jété un trouble réel dans la discussion, et qui consiste à considérer comme une seule et même chose les facules et les flammes gazeuses audessus de ces facules. Pour éclaircir ce point, je dois donner d'abord un aperçu rapide de mes propres recherches sur la question.

Dans le courant de 1891, j'ai étudié le spectre photographique des facules et taches solaires avec les spectroscopes les plus divers; j'ai employé le simple spectroscope à un prisme aussi bien que les grands réseaux de Rowland. Or, dans le spectre des facules et des taches voilées de rose, on aperçoit au milieu des larges raies noires H et K une raie brillante de renversement, qui est simple avec une faible dispersion, mais se dédouble avec un instrument plus puissant, en montrant elle-même un renversement par une raie noire centrale. La raie brillante correspond à une flamme de calcium audessus de la facule. J'ai présenté ce résultat et cette interprétation le 8 Février 1892 à l'Académie de Paris, en annonçant qu'il assure la recherche des flammes se projetant sur le disque même du soleil, et en indiquant les spectroscopes enregistreurs à deux fentes pour l'étude des formes et des mouvements de ces flammes. A peu près au même moment, Monsieur Hale, dont les recherches sur ce sujet ont été parallèles, presentait les mêmes faits, mais sans leur donner la même interprétation et sans annoncer la raie noire de renversement.

A cette époque j'etudiais la distribution de ces flammes sur le disque solaire par des moyens bien simples. Mon châssis photographique était fixé à la chambre par une coulisse en bois, ainsi que dans les chambres polyposes ou à répétition de la photographie ordinaire. Je déplaçais à la main le soleil sur la fente fine du collimateur de quantités égales, et en même temps aussi la plaque, également à la main, le spectre étant limité à la raie K du calcium et à son voisinage immédiat. Ce dispositif simple donne à la fois la position et la forme générale des flammes et aussi leurs vitesses radiales, et les détails des renversements. Il m'a permis d'annoncer (le 14 Mars 1892) que les flammes formaient en avant et en arrière de la grande tache de Février une série continue, et constituaient un véritable anneau dans l'atmosphère solaire. Ce résultat est le premier fourni par la nouvelle méthode, qui ait été publié. De son côté, Monsieur Hale faisait mieux encore pour l'étude des formes en réalisant un spectroscope enregistreur à deux fentes et à mouvement continu, appelé par lui spectro-héliographe, et qui donne en une seule épreuve les flammes du disque avec leurs formes exactes, sinon avec leurs intensités relatives. Il a reconnu plus nettement encore l'accord des formes données par l'ensemble des raies renversées avec les formes des facules, et a entrepris plusieurs travaux fort intéressants, auxquels je rends un juste hommage. Mais Monsieur Hale a présenté les images de son appareil comme fournies par les facules elles-mêmes, et il les appelées photographies de facules. Or je dois rappeler et maintenir ma première interprétation, qui est la seule admissible d'après les experiences bien connues sur le renversement. Les facules sont, par définition, les plages brillantes de la surface solaire, plages qui, à l'intensité générale près, donnent les mêmes raies noires que les parties voisines, et correspondent aux parties élevées, aux montagnes de la photosphère. Elles sont distinctes des flammes de calcium audessus d'elles. Il n'y a pas d'ailleurs, comme l'écrit Monsieur Hale, identité entre les formes données par le spectro-héliographe et les formes des facules, mais seulement accord général des formes; et cela est tellement vrai que les flammes apparaissent souvent audessus des taches, qui sont justement le contraire des facules. D'après mes recherches, il est plus juste de dire que les facules sont comme un squelette sur

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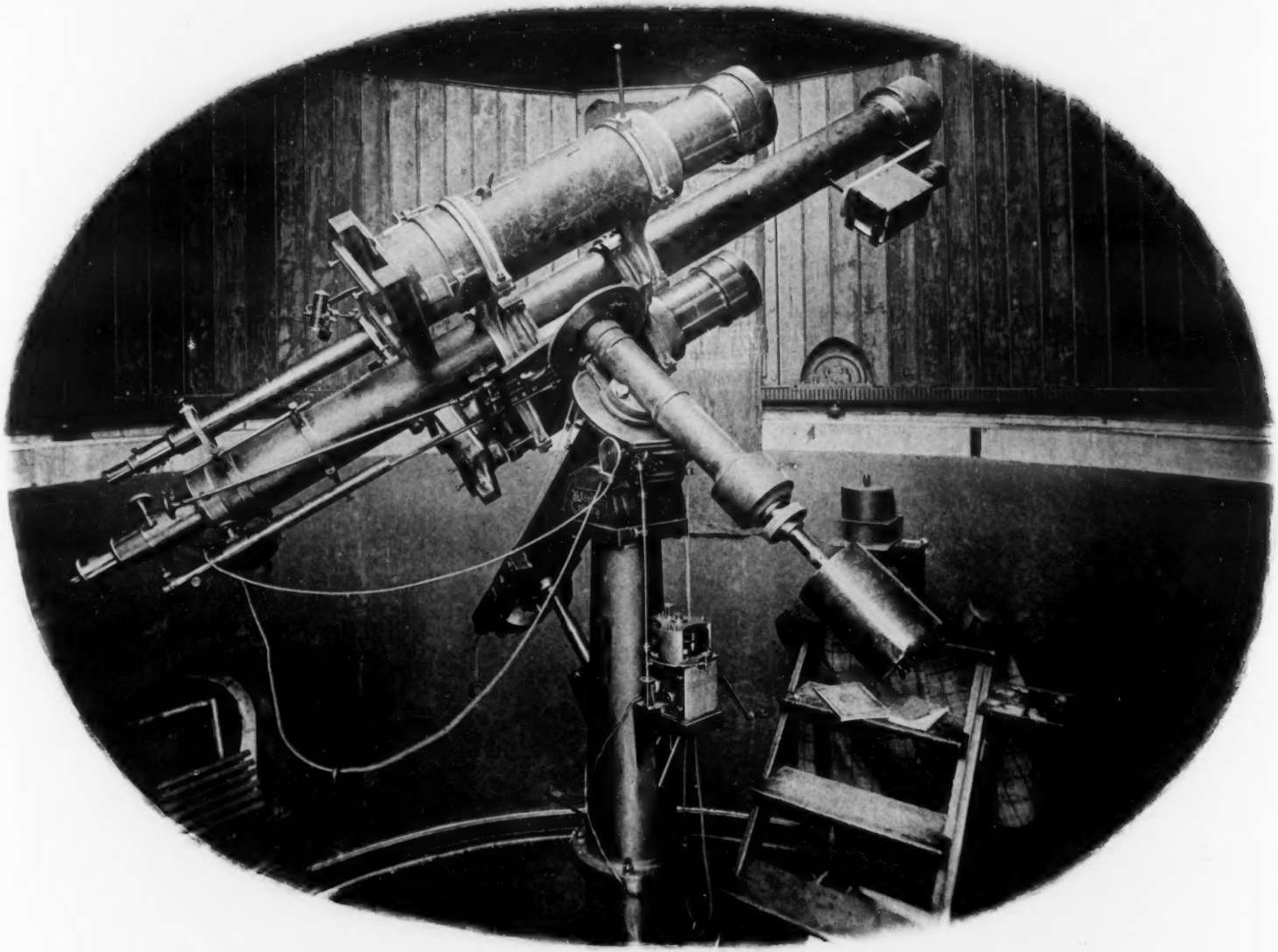

THE INTERIOR OF DR. MAX WOLF'S OBSERVATORY AT HEIDELBERG,

Showing the guiding Telescope with three photographic Cameras attached.

Direct Photo Engraving Company, 9, Barnsbury Park, N.

NORTH.

EAST. WEST.

METEOR TRACES ON A PHOTOGRAPHIC PLATE OF THE REGION OF THE MILKY WAY ABOUT ξ CYGNI.

The photograph was taken by Dr. MAX WOLF, of Heidelberg, on the 7th September, 1891. It shows that one of the meteors varied irregularly in brightness in its passage through the air. The stars and nebulous matter of the Milky Way are shown as photographed, with an exposure of one hour, in the focus of a portrait lens of 2½ inches aperture and 7·8 inches focal length. The plate is an enlargement from a part of the original negative.

Direct Photo Engraving Company, 9, Barnsbury Park, N.

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lequel les flammes se fixent en le recouvrant. Je propose à Monsieur Hale et à toutes les personnes qui étudient ces questions, d'appeler ces renversements du calcium *flammes faculaires*, nom qui est en accord avec les faits, et évite toute ambiguité.

Cette confusion a conduit en effet Miss Clerke à conclure que les facules sont beaucoup plus chaudes que la photosphère ; mais, après les explications précédentes, cette conclusion de Miss Clerke ne s'applique plus aux facules, mais aux flammes faculaires. En fait, je pense, comme Monsieur Maunder, que la température des facules doit être plutôt un peu moindre que celle de la photosphère, ou tout au moins que celle des parties basses de la photosphère. Sur la terre, le sol dans la montagne est plus froid que dans la vallée voisine.

Mais qu'est-ce donc que la photosphère ? La constitution indiquée par Monsieur Ranyard répond à tout, d'après moi, et explique toutes les particularités spectrales et autres. La photosphère est un nuage lumineux formé par des particules de métal fondu qui flottent dans un mélange de vapeurs. Le métal liquide a un grand pouvoir émissif et donne le spectre continu; la vapeur, dont le pouvoir émissif est faible mais le pouvoir absorbant considérable, donne les raies noires de Fraunhofer. La similitude du spectre au centre et au bord se conçoit aisément, de même aussi le réseau photosphérique de Monsieur Janssen, par de petites différences de condensation. La température du nuage solaire, ainsi que dans les nuages terrestres, est comprise entre le point de solidification du liquide et le point d'ébullition, qui varie beaucoup avec la pression, et donc doit dépendre de la masse et du volume de l'astre. Les différences d'éclat entre les étoiles sont ainsi explicables. (1)

Mais je reviens aux facules et à leur triple renversement, qui comprend une grosse raie noire, une raie brillante moins large, et une raie noire fine. Ce triple renversement, suivant l'expression même de Miss Clerke, indique une triple origine ; il annonce trois états successifs différents de la vapeur dans le sens de la hauteur. Mais tout d'abord, la raie brillante est d'origine électrique. Elle se présente en effet avec les raies de l'hydrogène, qui sont brillantes dans les taches voilées de rose, et partiellement renversées dans les facules. Or, plusieurs observateurs, et Monsieur Fizeau en particulier, ont remarqué que les raies de l'hydrogène ne peuvent être obtenues que par l'intervention électrique. De même aussi, d'après les recherches de Monsieur Lockyer, confirmées récemment par Monsieur Hale, les raies H et K du calcium ne se montrent brillantes et fortes, ainsi que dans le soleil, que par l'illumination électrique.

Les deux autres raies noires du renversement triple peuvent avoir la même origine, mais les expériences du laboratoire ne permettent pas de conclure à cet égard. Les grandes différences de largeur de ces raies s'expliquent aisément. Ces raies du calcium et de l'hydrogène sont connues en effet comme ayant la propriété de s'elargir lorsque la pression et l'intensité électrique augmentent ; à ce point de vue même, elles sont précieuses par les indications speciales qu'elles fournissent sur l'état de la vapeur.

Cependant les flammes faculaires sont formées de calcium et d'hydrogène ; elles ont la même composition que les protubérances ; ce sont des protubérances se projetant sur le disque. Cette identité des protubérances et des facules, que conteste Monsieur Hale, n'est pas douteuse ; toutes les observations oculaires et photographiques concourent à cette conclusion. Même l'analyse de la raie du calcium dans une protubérance permet de prévoir le renversement de la raie brillante dans la flamme faculaire. La raie du calcium dans la protubérance a la forme en fer de lance ; elle est large et intense à la base, mince et faible à la partie supérieure. Lorsque, par le fait de la rotation solaire, elle est vue dans le sens de sa hauteur, la partie basse de la raie, qui est la plus intense, donne la première impression, et la partie supérieure arrête la lumière du centre de la raie et donne la raie noire centrale. Et, en fait, le même temps de pose est nécessaire pour obtenir la base de la protubérance et la raie faculaire.

De plus, la base de la protubérance offre, quoique rarement, un déplacement dû à la vitesse dans le sens du rayon visuel ; de même aussi la raie des flammes faculaires. La raie faculaire présente parfois seulement un très leger déplacement, ou une legère dissymétrie des deux parties brillantes. Ces déplacements, en particulier, sont une preuve nouvelle de la distinction réelle entre les facules et les flammes faculaires. En fin, l'observation journalière des bords est et ouest du soleil montre les facules succédant aux protubérances et les protubérances succédant aux facules.

La photographie de ces raies brillantes de renversement donne donc la base des protubérances. Mais les épreuves nombreuses du spectre de régions diverses du soleil faites avec une fente étroite du collimateur à Stonyhurst, Chicago, et Paris, indiquent que les raies du calcium, très nettes sur les belles facules, se montrent souvent aussi sur le disque presque entier, mais faibles, ou à peine perceptibles. Ces petits renversements correspondent aux petites protubérances et à la chromosphère elle-même. La photographie des flammes *faite avec un appareil capable d'intégrer même les petits renversements donne l'image de la chromosphère telle que la verrait un œil sensible seulement au violet extrême, la photosphère étant enlevée.* Tel est le résultat auquel conduit l'analyse exacte des faits. D'ailleurs une pose plus longue donne les parties hautes de la chromosphère et des protubérances qui dépassent les bords du soleil ; et une pose encore plus longue donnerait les formes coronales, mais avec des dispositions spéciales (*Comptes Rendus*, Août 1891 et Mai 1893), si bien que la conclusion précédente s'applique d'une manière générale á l'atmosphère solaire toute entière. (2)

L'application de ces résultats aux étoiles, que j'ai indiquée avec ses conséquences (*Comptes Rendus*, Juillet 1892, Février 1893), et que Miss Clerke a développée dans son article, ouvre une voie d'investigation nouvelle et mérite une mention spéciale. Lorsque l'on étudie le soleil, comme une étoile, en recevant dans l'appareil la lumière de tous les points à la fois, on a parfois, au milieu des larges raies noires H et K, une très petite raie brillante renversée. Cette raie, dont l'existence a été verifiée à Stonyhurst, représente l'intensité moyenne des flammes faculaires, et ses déplacements par rapport aux autres raies sont liés aux mouvements généraux des flammes par rapport à la terre. Elle apparaît bien avec un spectroscope puissant et surtout une pose un peu longue. La recherche de raies similaires dans les étoiles serait à coup sûr longue et difficile, mais elle permettrait de reconnaître la nature, les variations, et peut-être aussi les mouvements généraux de la chromosphère dans les étoiles.

Postscriptum.—Je vous donne aussi comme un complément mes premiers résultats sur la photographie des flammes solaires, résultats qui sont à certains égards différents de ceux présentés par Monsieur Hale. J'ai reçu en effet récemment du ministère des crédits spéciaux pour la construction d'enregistreurs des flammes solaires,

(1) Ces différences dans l'absorption par l'atmosphère jouent aussi évidemment un rôle important.

(2) Ou tout au moins à la partie gazeuse de cette atmosphère, l'emploi d'une radiation autre que celle du calcium permettrait de distinguer les formes données par l'ensemble des particules qui fournissent le spectre continu de la couronne.

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et j'ai fait cet été une série d'essais. Monsieur Hale, dans ses dernières comme dans ses premières publications, emploie pour la photographie des flammes par le système à deux fentes, la plus forte dispersion de son spectroscope à réseau, soit le spectre de 4e ordre. Or la théorie et l'expérience me conduisent à la conclusion contraire ; une dispersion très faible est bien préférable. Théoriquement, la netteté la meilleure et aussi l'intensité réelle des flammes sera obtenue lorsque la fente devant la plaque sera aussi écartée, aussi large que la fente du collimateur, et de plus contiendra toute la raie de la flamme, et nulle autre lumière. Ces conditions sont impossibles à réaliser exactement, mais on s'en approche d'autant mieux que les fentes sont plus fines et que la dispersion est plus faible. (3) Car la raie du calcium est de facile expansion ; avec une forte dispersion, une fente fine ne reçoit qu'une partie de la raie qui est trop large ou déplacée, ou même ne reçoit que la raie noire centrale. On est alors obligé d'ouvrir la fente et de compromettre la netteté des images. (4) Les photographies de Monsieur Hale sont très belles ; mais pour augmenter encore les détails, Monsieur Hale réclame un objectif plus grand donnant une plus grande image du soleil sur la fente du collimateur ; il convient tout d'abord de tirer le meilleur parti possible des appareils existants. Pour ma part, j'ai obtenu cet été des photographies de la chromosphère donnant tous les détails des flammes avec un sidérostat, un miroir de six pouces, et un spectroscope à un seul prisme donnant un écartement de H et K de 2 millimètres ; l'image de la seconde fente était grossie trois fois—un grossissement plus grand aurait été encore meilleur. (5) L'image finale est circulaire, le diamètre étant de 0·06 à 0·07 centimètres.

Mais la photographie des formes des flammes n'est pas suffisante. La solution complète, ainsi que je l'ai réclamé déjà en 1891, comporte l'enregistrement des vitesses radiales et des détails des renversements (6) par des sections successives équidistantes dans l'image du soleil.

Mais, pour ce cas nouveau une grande dispersion est nécessaire. J'emploie donc à la fois deux spectroscopes, l'un de faible dispersion pour l'enregistrement des formes, l'autre de grande dispersion pour les vitesses radiales. Les deux spectroscopes sont côté à côté, et analysent ensemble une même image du soleil, fournie par un seul objectif. Ils marchent ensemble (dans les deux sens) à la même vitesse moyenne, celui des formes avec mouvement continu uniforme, celui des vitesses avec un mouvement uniformément variable. L'appareil résultant enregistre simultanément, et d'une manière continue, les formes et les mouvements des flammes de l'atmosphère solaire.

[Perhaps I may be allowed to follow the example of Monsieur Deslandres, and commence by criticizing the use of certain terms which seem to tend to confusion. M. Deslandres uses the words "flammes gazeuses" for the gaseous forms which we in England now generally speak of as solar prominences. Some thirty years ago prominences were very frequently spoken of in England as solar flames, but the term, which seems to imply chemical action, has now dropped out of use with English writers, because it tends to beg the important question whether chemical changes producing light and heat are going on upon the sun.

M. Deslandres also speaks of *l'atmosphère solaire* ; but the word "atmosphere" implies a gaseous envelope in which one layer rests upon and compresses the layer immediately below it—a condition of equilibrium which the facts at our disposal, as to solar temperatures and the intensity of solar gravity, preclude us from supposing exists upon the sun above the level of the photosphere.

I cannot concur with M. Deslandres in regarding it as proved that hydrogen can only be made to shine by means of electricity. There is a tendency to take refuge in electrical assumptions whenever we find ourselves confronted by facts we cannot readily explain. Iodine vapour can be made incandescent by the application of heat, and why should we, with our small experience, obtained in terrestrial laboratories, assume that other vapours cannot also be made to shine by the application of sufficient heat ?

It seems to me that the differences between the spectra of prominences, as seen at the sun's limb and when looked down upon as faculæ on the sun's disc, are probably due to the rate at which the temperature increases on entering the gaseous mass. According to the theory of exchanges as ordinarily stated, it is difficult to conceive how any gaseous mass can emit a bright-line spectrum, for the outer envelopes of a gaseous mass will always be cooler than its interior, and the cooler gas ought to absorb the radiations emitted by similar gas at a higher temperature ; but as a matter of fact such hot streams of gas do give a brilliant bright-line spectrum. But when the same streams are seen upon the bright background of the photosphere, and the line of sight passes through the cooled vapour which forms the head of the prominence, we, in the case of calcium vapour, see a broad band of absorption, on which are two bright lines, separated by a dark interval. But I had better leave the further discussion of this interesting question to Prof. Hale, who will, I hope, put the facts more clearly than I can in the January number of Knowledge.—A. C. Ranyard.]

(3) On est arrêté dans cette direction par les inconvénients des fentes très fines et des poses très longues. Les fentes doivent en effet toujours être plus petites que la grosse raie noire, qui est encore large d'ailleurs avec les petits spectroscopes ordinaires de laboratoire.

(4) Dans le dispositif adopté par Monsieur Hale, le spectroscope est fixé et les deux fentes mobiles ; ce qui exige un élargissement supplémentaire de la fente devant la plaque. Ce dispositif, malgré les avantages qu'il présente au point de vue mécanique, doit donc être écarté.

(5) Ces photographies ont été faites avec le concours de mon assistant, Monsieur Mittau.

(6) La raie noire centrale a une largeur variable, qui dépend en grande partie de la pression et donc de la hauteur à laquelle se produit le renversement. Si, dans ces photographies par sections successives on réunit par une courbe les points ayant la même largeur de la raie centrale, on obtient des courbes analogues aux courbes de niveau des cartes topographiques.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

To the Editor of Knowledge.

Dear Sir,—As there seems to have been some misapprehension regarding my use of the word "layer" in a letter published in the October number of Knowledge, I beg permission to define my meaning more clearly. In referring to a "layer" of comparatively cool calcium vapour which exists above the photospheric level, and causes by its absorption the reversal of the bright H and K lines of the faculæ, I did not mean it to be inferred that the absorbing vapour is in a condition of static equilibrium, or that it is of uniform depth. I agree with you that it seems much more probable that the vapour is constantly in motion, and is not in the condition of an atmosphere.

It is certain that the bright regions on the sun's disc photographed with the spectro-heliograph do not in all

respects agree with the faculæ which are visible to the eye when near the sun's limb. In many cases small spots, which are clearly visible to the eye in direct observation or in photographs taken at the focus of a telescope in the ordinary manner, are completely hidden in spectro-heliograms by bright patches in which H and K are reversed. Hitherto the name "facula" has been applied indifferently to the visible and invisible phenomena, but it seems desirable that a distinction be made. The true faculæ give a continuous spectrum in addition to the doubly-reversed H and K lines. In the invisible "faculæ" the continuous spectrum is either very faint or altogether lacking.

As you have been kind enough to request me to discuss the nature of faculæ more at length in a paper for KNOWLEDGE, I need not pursue the subject further at the present time. Very truly yours,

GEORGE E. HALE.

EXPLOSIONS IN THE SUN.

To the Editor of KNOWLEDGE.

DEAR SIR,—I am much obliged to Prof. Smithells for his interesting criticism of my letter on the above subject, which was written chiefly to point out that explosive combinations of gases cooling from above their dissociation temperatures would not *necessarily* take place. I quite agree that it would be absurd for anyone to argue the impossibility of such combinations, seeing that we have no experience to guide us as to the behaviour of the elements under solar temperatures.

At the same time I think it is permissible, by reasoning upon the little we do know, to see how far the observed solar phenomena can be explained; and I must maintain that our chemistry fails at present to account for the fact of solar explosions in the same sense that it accounts for terrestrial explosions. Even if we make the assumption suggested by Prof. Smithells, that the gases become super-cooled before combining, it is still difficult to believe that the explosive force would be anything approaching in intensity that of (say) an explosion of oxygen and hydrogen at ordinary terrestrial temperatures; for if we suppose the dynamical theory of gases to be a fair approximation to the truth under solar conditions, it will follow that the absolute temperature at dissociation would have to be reduced by super-cooling by as much as one-half to produce an expansion which would even double the volume with equal pressures. For whatever assumption we make as to the law of increase of chemical affinity with decrease of temperature, in no case can the temperature of the resulting compound rise above the dissociation point; combination may be incomplete, but the volume (under constant pressure) cannot increase in a greater ratio than the dissociation temperature bears to the combination temperature.

Taking as an example the case of dissociated oxygen and hydrogen cooling uniformly and under constant pressure, for the sake of argument, the sequence of phenomena would be as follows: both temperature and volume of the mixture decrease uniformly until a certain temperature has been reached below the dissociation point (supposing the super-cooling to be a fact). Then, either a portion or the whole mass will suddenly combine, the amount depending on the quantity of heat withdrawn in super-cooling; and, apart from the energy due to chemical affinity, an amount of heat will be evolved (latent heat of dissociation) exactly counteracting the contraction due to the combination, the heat of chemical affinity alone being effective in producing an expansion, and this, as explained above, cannot be greater than the ratio of the absolute temperature at combination to that at dissociation.

To return, however, from theoretical arguments to a consideration of the phenomena actually observed on the sun. From my own personal acquaintance with the chromosphere, I am inclined to doubt whether the evidence relied on to prove the superficial origin of the "explosions" is conclusive, or even real; and I think that too little attention has been paid to certain phenomena which indicate that these outbursts may often originate at a considerable depth below the photospheric cloud layer, and therefore in a region presumably more or less shielded from the effects of cooling by radiation. Thus, in looking over my own observations, which extend over a period of five years and comprise more than five hundred separate drawings of the chromosphere, I can find no single instance of an eruption, great or small, showing the principal motion inclined more than about 40° from the vertical; in general, these visible motions differ but little from a radial direction. It is true that displacements of the bright lines at the solar limb, indicating tangential motion, are frequently seen in active prominences, but this is often found to be only a fractional *component* of the real direction of motion. Another fact bearing on this question is the enduring nature of the centres of eruption. Many metallic and eruptive prominences have been seen to reappear alternately east and west after intervals equal to one or more semi-rotations. These are usually associated with spots, and have been found to even outlive a large spot. Thus, the great group of February, 1892, was heralded by an eruptive prominence on February 4th, and subsequently, similar violent eruptions were seen by various observers in the same latitude on February 18th and 19th, March 3rd and 4th, March 18th, May 11th and 12th, and finally, June 5th, all of which can be referred to the same heliographic position, the last-mentioned alone being observed two days before it was theoretically due on the west limb. The recurring nature, or rather longevity, of the quieter high latitude prominences I have found to be still more marked, and from this one is led to believe that many of these supposed transient phenomena are the outcome of forces as deep-seated and of as enduring a nature as the spots themselves. Yours truly,

J. EVERSHED.

[While concurring with Mr. Evershed in thinking that the long-enduring solar prominences and sunspots probably have a deep-seated origin, it seems to me improbable that structures like the tangential rays of the corona and the numerous prominences which exhibit an inclination to the radial, have their origin at a great depth, and on reaching the level of the photosphere are deflected to continue their course in approximately straight lines.

The differences of rotation period of the photosphere in different latitudes, as well as of the absorbing material which gives rise to the Fraunhofer lines at various distances from the solar equator, seem also to point to a continual radial circulation outward as well as inward from the photosphere. Whether such radial motions in the outer parts of the sun are due to explosions at a high or low level, or to fierce winds due to the rapid fall of cooled material under the powerful influence of solar gravity, is a matter on which I at present keep an open mind; but I should like to point out that the lateral motions observed are not inconsiderable, and that the effect of perspective cannot increase any apparent inclination to the radial. A ray which is inclined to the radial may be seen in projection so that it appears radial, but any apparent inclination to the radial must be real.

Motions in the line of sight at the sun's limb corresponding to three hundred miles a second have been observed, and since we know that a radial velocity of three hundred and eighty-three miles a second at the level of the photosphere would suffice to carry matter permanently away from the sun, it seems probable that prominence matter occasionally moves in directions very considerably inclined to the radial, but such lateral motions can, it seems to me, be as easily accounted for on the wind theory as on the explosion theory of the origin of solar prominences.—A. C. Ranyard.]

LIGHTNING PHOTOGRAPHS OR PHOTOGRAPHIC DEFECTS.

Gore Lodge, Glenageary, co. Dublin.
14th October, 1893.

To the Editor of Knowledge.

Sir,—I enclose two photographic prints, which I am told may interest you; they are from negatives exposed under the following circumstances. During a holiday in Switzerland, at the latter end of August last, on a beautiful moonlight night, I was tempted to expose a plate in a small hand camera, the exposure, which was made from my bedroom window, being one hour, from about 10 to 11 p.m. Next morning I took a snap shot of the same scene; the prints I send are from the resulting negatives. The peculiar marks on the "moonlight" print showed up in the negative soon after placing in the developer, and I was at first inclined to throw the negative aside thinking it had been spoiled; for, owing to my plates getting mixed, I did not at the time know I was developing the moonlight exposure, or I might have treated it in a different manner, with perhaps better results. I can only attribute the zigzag marks to lightning, and thinking they are such I send the prints to you, understanding you would be interested in examining them.

I shall be pleased to have your opinion, or to give you any further particulars in my power.

Yours truly,

Robert R. Levingston.

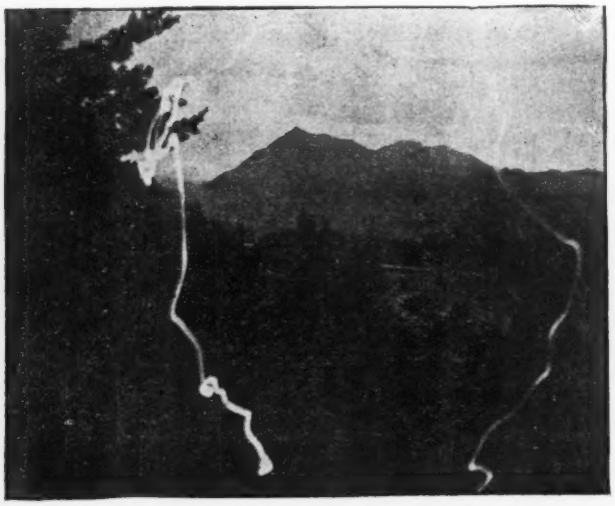


Fig. 1.—Moonlight photograph, exposed during one hour.

Fig. 2.—Photograph of the same view taken the next morning.

[In answer to a letter asking for the focal length of the camera with which the photographs were taken, and inquiring whether Mr. Levingston had seen any lightning or heard the sound of thunder during the moonlight exposure, he replied:—]

Gore Lodge, Glenageary, co. Dublin.
23rd Oct., 1893.

Dear Sir,—I delayed replying to your kind letter of 19th inst., to procure the particulars you ask for as to "focal length" from a friend who has purchased from me the little camera in which the photographs referred to were taken.

The camera has, I learn, a "focal length" of 4½ inches.

The night on which the "moonlight" picture was taken was an extremely bright moonlight night, and, by way of experiment, I placed the camera on the window-sill, giving just an hour's exposure. I was not aware of any lightning or thunder, but there were no marks on the plate when I put it into the developer, and the "*lightning*" (?) marks developed out in a most regular manner, the *brighter parts* coming out very quickly after putting into the developer; furthermore, the line mark at the edge of the slide is quite clear in the negative, and no "lightning" marks appear underneath or outside this line, where, of course, the light did not act. I am led to refer to the latter specially, because the Editor of *Photography* hinted that the marks may have been pencil marks.

You are quite at liberty to publish the photos, and if I can help by any further details, I shall be glad to do so.

Yours truly,

A. C. Ranyard, Esq. Robert R. Levingston.

[If the marks on the moonlight photograph were due to lightning the flash must have been very close to the hotel window, for it will be noticed that the band of light seems to run into a complicated knot or tangle in front of the branch of a tree at no great distance in the left hand foreground. Such a flash of ordinary lightning, discharged so close to the hotel, would probably have been accompanied by a clap of thunder which the visitors at the hotel could hardly fail to have heard.

Though the trace upon the plate has a general

resemblance to a lightning photograph, it will be found on closer examination to exhibit important differences. Lightning pursues an irregular jagged course through the air, but here the curves are rounded and the band is uniform in brightness from one side to the other. In the so-called ribbon flashes of lightning one side of the ribbon is much brighter than the other, and a series of bright lines may be traced running parallel to the bright edge; for there are usually several discharges at intervals of a few hundredths of a second, which, as a general rule, follow the same course. The first flash, in finding a path of least resistance through the air, probably jumps from one dust particle to another, and having once heated the air along its jagged path, the succeeding flashes, as a general rule, follow the same course of least resistance, as if they were flowing down a pipe. Ribbon flashes of lightning are usually found to have been photographed with cameras which have been held in the hand, and it may be assumed that the operator has moved with the camera in the interval between the flashes. But, as Mr. Symons has pointed out, it is possible to conceive of a ribbon flash being produced with a stationary camera. Thus, if a wind were blowing at the rate of twenty miles an hour across the line of sight, the moving air would, in the interval between the flashes, which sometimes amounts to as much as the fifth of a second, have carried the dust particles and the pathway of heated air through a distance of nearly six feet. The second flash, therefore, if not very distant from the fixed camera, might occupy an appreciably different position on the photographic plate, and a succession of such flashes might give rise to a ribbon-like flash although the camera was stationary.

But in this case there is no stratification of the ribbon-like band, and the band, though it differs in brightness in different parts, is everywhere of the same breadth, while a ribbon flash of lightning differs in breadth at different parts of its path, being always broadest where the lightning path is at right angles to the direction of motion of the photographic plate or of the wind, and narrowest where the direction of motion is tangential to its curved path, in which latter case the curve is only displaced upon itself.

I would suggest that it is not improbable that Mr. Levingston, after having made his moonlight exposure, took his little camera up from the window-sill, and, forgetting that the direct light of the moon would make a trace upon the plate, turned the camera upwards while he looked about for the cap with which to cover the lens, or while he passed the camera from one hand to the other and closed the shutter over the dry plate. The block (Fig. 1) is about the same size as the original negative, and the white band upon it is about the twentieth of an inch in diameter, which corresponds to the diameter of the moon as photographed in a camera of 4½ inches focus.—A. C. RANYARD.]

OUR RAINFALL IN RECENT YEARS.

By ALEX. B. MACDOWALL, M.A.

WE are all familiar with the instructive rainfall map, in which the character of different places, as regards wetness, is shown by different shades or colours. And in the case of Great Britain, the wettest places, as everyone knows, are to be found among the mountains of the west, while the driest are in the east.

These maps are constructed from averages of rainfall in a series of years. One naturally asks, How has the rainfall varied from year to year in different parts of these islands? What is the recent history of its fluctuations? An answer to such questions is to be found in tabulated figures of that excellent annual publication, *British Rainfall*, issued by our chief rainfall authority, Mr. G. J. Symons.

As the true meaning of a column of figures is not always on the surface, I propose to call in the aid of curves, with a view to better comprehension. The curves here used will be smoothed curves, smoothed by means of five-year averages. That is to say, each year-value will

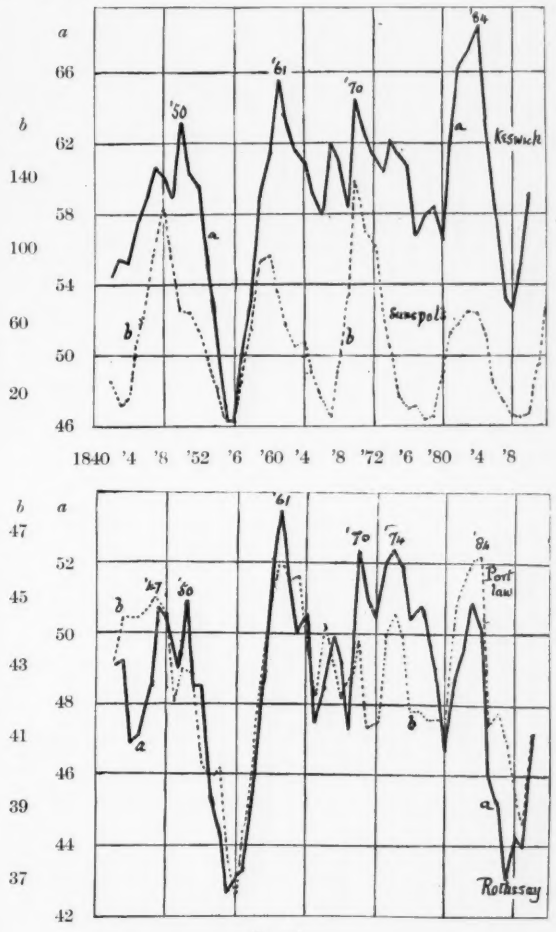


FIG. 1.

be that, not of the actual rainfall, but of an average of five years. In this way the general course and significance of a curve can be better appreciated.

It might perhaps be thought that, a number of such curves for different places in the country having been brought together, we should find them all pretty much alike, though differing slightly in detail. It is not so. While certain groups present a common type, it is possible to find curves which have very little resemblance to each other.

Let us begin by considering a group of curves from the west.* Here (Fig. 1) is the smoothed curve for Keswick,

* In these diagrams the rainfall scale is varied at convenience. The figures denote inches. Where two scales are given, the respective curves are indicated by letters *a* and *b*.

in the Lake District (from 1840); and further down, that for Rothesay, in Bute. These are distinctly alike, and I find that the curve for Portlaw, in Waterford (added in the lower division), may fairly be ranked with them. The Rothesay curve, from 1856, might be roughly described as forming a long three-crested wave. We are in a position to carry back the curve to the beginning of this century, and the first part here given (*before* 1856) proves to be the third part of another long triple-crested wave, commencing in 1822.

Now there is an interesting correspondence, in these Keswick and Rothesay curves, to the sunspot curve (which is shown in the upper division). The sunspot maxima occurred in 1848, 1860, 1870, and 1883; and, taking the Keswick curve, we have relative maxima in 1850, 1861, 1870, and 1884. The general course of the curves is similar.

This correspondence, at least in the case of Rothesay (which has been previously noticed*), can be traced back to early in the century (in the first decade it seems to fail). Our interest is naturally roused by it; but to affirm a causal relation between the phenomena may be considered at least premature. Certain anomalies met with in the actual values, and pointed out by Mr. Abercromby, call for consideration, though we may not quite accept his view about smoothing processes. It might seem to some a sufficient condemnation of the sunspot theory, that we have not the same kind of curve everywhere else. But with the meteorological knowledge of to-day, it may fairly, I think, be argued, that opposite weather in two regions (*e.g.*, great wetness in one, and great drought in another) might both be traceable to the condition of the sun, as revealed by spots. On this point, however, I must not linger.

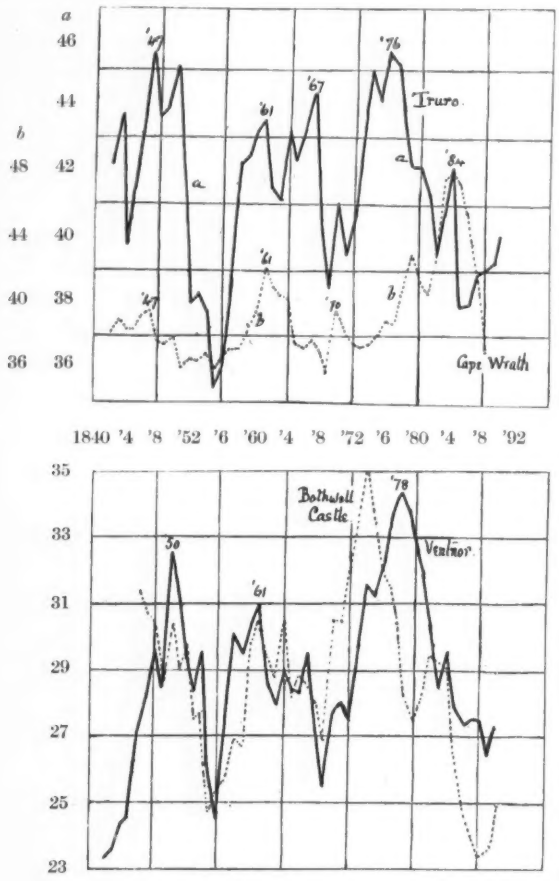


FIG. 2.

Over what extent of region, precisely, this kind of curve is obtainable, I cannot say. If we go up to Cape Wrath, however, or down to Truro, we find in both cases a different *régime*. The curves for these places are shown in Fig. 2 (upper half).

The curve for Cape Wrath, indeed, culminates about the same years, but in the general relation of different parts of the curve there is considerable change. The Truro curve might perhaps be described as forming three long waves.

Another three-wave curve is that of Ventnor (lower division of Fig. 2), and one meets with several curves of this type in different parts of the country, even widely apart. Speaking generally, there is first a prominent wave-crest in one of the years 1846-50, then a crest about 1861, and the third, most conspicuous of all, somewhere in 1874-80; from which point the curve descends rapidly and with little break to a low point about 1888. With the Ventnor curve I give that for Bothwell Castle, in Lanarkshire, N.B., which has its third crest in 1874, while that of Ventnor is in 1878. The curve for Brechin, east coast of Scotland (Fig. 3), has also three waves, with the third culminating in 1877. Other cases might be given.

The Sheffield curve (Fig. 3) might perhaps be regarded as a kind of transition form to what we find in the east of England (shown below). This East Anglian curve is one for Dickleburgh, in Norfolk, and (last eighteen years) for Norwich. From a high point in 1843 the curve (roughly speaking) takes a long downward sweep, and rises again to a high crest in 1877. (The Oxford curve is very similar, only the earlier culmination is in 1850.) In a curve for Boston, Lincolnshire, the two chief crests are in 1847 and 1881.

In the Greenwich curve (not given) a high point is reached at 1867 (compare Truro and Ventnor), in addition to crests at 1850, 1861 and 1879, which latter is the highest.

In a remarkable work published a few years ago, Prof. Brueckner, of Berne, has traced variations of climate in different parts of the globe since 1700; and from a large induction of facts, he infers the existence of a weather cycle of about thirty-five years in the greater part of the land surface of the earth. It is interesting in this connection to note that Lord Bacon, in one of his essays ("On the Vicissitudes of Things"), refers to such a cycle as being spoken of in the Low Countries.

Taking recent years, Brueckner finds that there was a cold and wet period from about 1841 to 1855, and again from 1871 to 1885, while the period between these (1856-70) was warm and dry. The east of England is included by him among the regions for which this rule holds, and our East Anglian curves are quite in accordance with this view. In certain regions (comprising Ireland, Scotland, West England, the Atlantic islands, &c.) the variations are stated to be exceptional.

The following years, according to Brueckner, are, approximately, centres of cold and wet periods—1700, 1740, 1780, 1815, 1850, and 1880; while the following are centres of warm and dry periods—1720, 1760, 1795, 1830, and 1860.

* See Abercromby's *Weather*, p. 325.

These diagrams deal with weather in the past; do they afford any clue to the future?

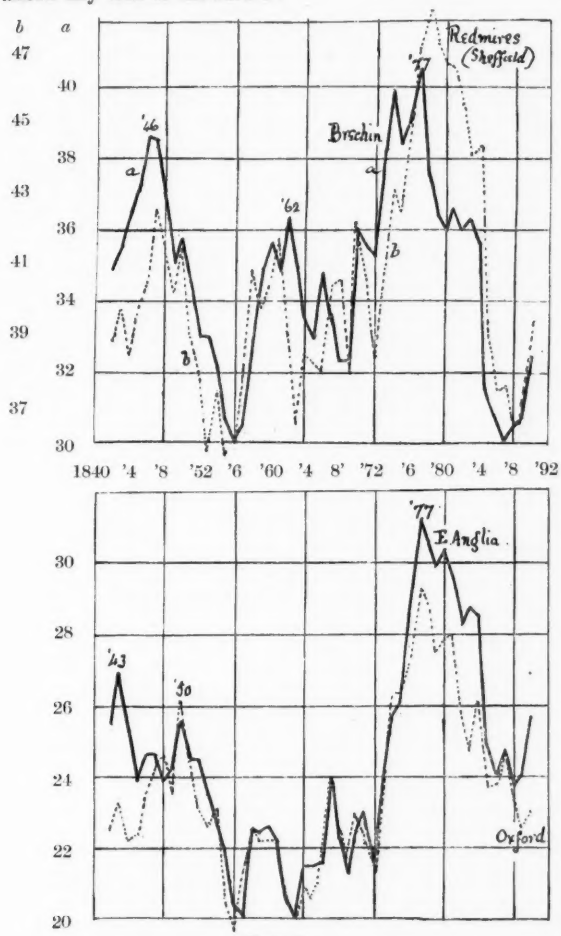


FIG. 3.

In the case of the Rothesay curve and others like it, whatever view we may take of the correspondence with the sunspot curve, the fact of that correspondence having subsisted so many years seems to afford some basis for expecting it to continue; in which case the curves would now be nearing another maximum. On the other hand, there is the thirty-five years' period in the east of England (a period which, by the way, is just about three times that of the solar cycle). Should this cycle of Brueckner's continue to be realized, we might expect those smoothed curves to attain their next conspicuous maximum somewhere about 1912. With regard to the other curves there is not much to be said. They appear to have all lately passed a low minimum, and the rise seems likely to continue. The present crest-interval (reckoning from the last prominent crest) promises to be longer than eleven years. The recent years, 1887, 1888, 1889, 1890, and 1892, have all (according to Symons) shown a deficiency of rainfall in England, and we may reasonably infer that the years now approaching will be wetter, though the wetness might not appear in the summer half of the year, when it would be most noticed. But in all such endeavours to penetrate the future, it is wholesome to bear in mind the plentiful stultification to which over-confident weather prophets have had to submit hitherto.

NITROGEN AS FOOD FOR ANIMALS AND PLANTS.

By VAUGHAN CORNISH, M.Sc., F.C.S.

"THE atmospheric fluid, or common air," Lavoisier wrote, "is composed of two gases or aëriform fluids, one of which is capable, by respiration, of supporting animal life, and in it metals are calcinable and combustible bodies may burn; the other, on the contrary, is endowed with directly opposite qualities—it cannot be breathed by animals, neither will it admit of the combustion of inflammable bodies, nor of the calcination of metals.

"We have given to the base of the former, which is the respirable portion of atmospheric air, the name of oxygen. . . . The chemical properties of the noxious portion of atmospheric air being hitherto but little known, we have been satisfied to derive the name of its base from its known qualities of killing such animals as are forced to breathe it, giving it the name of *azot*, from the Greek privitive particle *a* and ζωη, *vita*; hence the name of the noxious part of atmospheric air is *azotic gas*."

Lavoisier, who was the first clearly to state the chemical nature of air as composed of two substances, one chemically active and the other chemically inert, occupied himself for many years in developing the knowledge of the chemistry of oxygen—the active constituent of air. The readiness with which oxygen gas can be made to act upon and combine with other substances enables its chemical functions to be determined with comparative ease, and the mode in which this element is used in the nourishment of the animal body was soon elucidated with tolerable completeness; on the other hand, the inertness of *azot* (or nitrogen, as the substance soon came to be called in England) rendered the chemical study of this constituent of the atmosphere a less attractive as well as a slower and more laborious pursuit. Thus, if we compare the ways in which the oxygen and nitrogen of the air are taken hold of to build up the animal body, we find that one process is direct and in its main features simple, whereas the processes by which the nitrogen of the air becomes a constituent of the flesh and muscle are, on the contrary, indirect and complicated. Even at the present time, a hundred years after the researches of Lavoisier, the mode of "assimilation of nitrogen" is only beginning to be understood. When air enters the hollow cells of the lungs, the blood, flowing round the cells in little veins and capillaries, seizes upon and "fixes" the oxygen, which freely passes through the thin walls of the air-cells, and carries to every part of the body the combined oxygen which it has thus seized upon. Parting in its passage through the body with the oxygen which it has seized from the air, the blood acts as carrier of oxygen from the air to the muscle, flesh, nerve, and other parts of the body. But the blood has no power to seize upon and fix the nitrogen gas which enters the lungs at every breath. The blood has to obtain its nitrogen from the animal and plant food which is taken into the stomach; the throat and not the windpipe is the channel by which the nitrogen of the air is supplied to the body. Animals used by man for food obtain their nitrogen from plants. Plants have to depend ultimately upon the air for their supply of nitrogen.

The plant, however, does not appear to be able to assimilate the free atmospheric nitrogen through its leaves any more than an animal can assimilate the gas through its lungs. Leaves catch the carbonic acid of the air as the lungs of animals catch the oxygen of the air; but the nitrogen, it seems, has to reach the sap through

XUM

the roots—it has to be fixed in some way—before the plant can feed upon it. Recent researches seem to have proved that on leguminous or pod-bearing plants there lives a class of bacteria which have the power of feeding directly upon the free nitrogen of the air. They "fix" the nitrogen, which afterwards becomes available for plant food. Perhaps this only happens after the death of the bacteria, when their substance has undergone decomposition and the nitrogen compounds have been converted into a soluble form so that they can enter the sap in the same way as the rest of the food derived by plants from the soil.

The soluble form in which it appears that nitrogen is mostly taken up by the roots of plants is known as the nitrate "form" or state of combination, in which nitrogen is combined with oxygen as it is in nitre and in nitric acid. Besides bacteria associated with leguminous and possibly other orders of plants, there is another agency which brings the nitrogen gas of the atmosphere into combination with oxygen; this agent is electricity. Electric discharges in the atmosphere cause the combination of relatively small quantities of nitrogen, and the soluble oxides of nitrogen thus formed are carried down in solution by the rain, thus adding to the quantities of nitrates in the soil. As far as it is at present known, these two agencies, electricity and bacterial life, are the only carriers of nitrogen from the air to the soil.

Most of the nitrogen at any moment present in the world's soil is, however, derived from the substance of the preceding generations of plants. The nitrogen required to be supplied to the world's soil for the crop of any one year is only the difference between what is abstracted from the soil by the plant crop and what is restored to the soil by the death and decay in the vegetable and the animal kingdom.

The difference between the two amounts may be relatively small for the whole of the earth's surface, and might perhaps be *nil* if large quantities of nitrogen as nitrate were not being constantly carried into the sea by rivers.

The nitrogen in vegetable and animal substances is combined with carbon, and nitrogen in this state of combination may be termed *organic nitrogen*. Nitrogen when in this form is not directly available as a food for plants. By the process termed decay in the case of plants, and putrefaction or decomposition in the case of animals, the nitrogen is set free from its combination with carbon, and ammonia or a compound of ammonia is produced. In ammonia, nitrogen is in combination with hydrogen; and nitrogen, in this state of combination, we will call *ammoniacal nitrogen*. Free ammonia gas, formed in the decomposition of materials containing organic nitrogen, is ultimately brought into the soil in a state of solution by means of rain or dew, owing to the fact that ammonia gas is extremely soluble in water. Much of the ammonia produced by the decomposition of organic matter meets at once either with water or with some material with which it can combine, and thus from the first is retained in the soil. Plants are able to feed directly upon ammoniacal nitrogen; but in the greater part of the nitrogenous food of plants the nitrogen is in combination with oxygen, *i.e.*, in what we have termed the "nitrate" condition. The decomposition of the organic matter of the soil (which is commonly called *humus*) is effected through the agency of the *nitrifying bacteria*. They first split up the organic matter into water, carbonic acid, and ammonia, and then further assist the oxidation of ammonia to nitric acid. The conditions favourable to nitrification are that the oxygen of the air should have free access, that the soil should be sufficiently moist, but not water-logged, and that the temperature should be fairly high. In the presence of an alkali, or alkaline earth in the soil, the nitric acid forms a salt (termed a nitrate). Where lime or carbonate of lime is present, soluble calcium nitrate is produced, and in this form plants obtain much of their nitrogen. Where potash is present, nitre or saltpetre is formed, as, *e.g.*, in dry districts of India, where nitre is found as an efflorescence on the surface of the soil. Chili nitre, or Chili saltpetre, is the nitrate of sodium, and occurs in large deposits in the rainless districts west of the Andes, in Chili and Peru. In a wet climate such deposits would be speedily washed away, and carried into the rivers and the sea. We have referred before to the loss of the nitrogen which the soil of continents undergoes on account of soluble nitrates finding their way into the sea. The great quantities of nitrates from Chili and Peru which have of late years been applied to the fertilization of the land are a contribution won back from the ocean; the nitrates of the nitrate beds have been formed by the oxidation of guano, the *dejecta* of fish-feeding sea birds. Recently "artificial guano" has been manufactured to a considerable extent from the carcases of coarse fish, caught for the purpose by fishing from ships specially employed in connection with this manufacture.

Where crops are cut and carried from the place where they were grown, it is necessary to provide for the restoration to the soil of certain materials, particularly nitrogen, which are thus removed instead of being allowed to return to the soil through the death and decay of the plants, as would be the case in a state of nature. This is partially effected by returning to the soil the manure from the animals of the farm which fed upon the crops. When the beasts themselves, however, are sent into the towns, they carry away large quantities of the particularly valuable constituents of a fertile soil, such as nitrogen and phosphorus. In a more primitive condition of agriculture, the beasts would be eaten on the farm itself, and the greater part of the nitrogen, &c., would find its way back to the soil whence it came. Facilities for communication and transport, however, and the concentration of the population in towns all tend to make farming, more particularly manuring or soil-feeding, a more complicated matter. This is especially the case where nitrogenous stuff, *e.g.*, hay, is sold off the farm, instead of being consumed upon it, and oil cake, or other artificial feeding-stuff is purchased in its place. The oil cakes are rich in fat as well as in nitrogen, but the albuminoid ratio is always high, in some cake as high as 5 : 7. The method of calculating the nutrient or albuminoid ratio was explained in a former article (*vide* Knowledge, July, 1893). Account has to be taken of this ratio in deciding upon combinations of artificial foods for the use of stock, just as the authorities of prisons, &c., have to consider the nutrient ratio of the diet they supply. Young growing animals retain a larger proportion of the nitrogen supplied to them than the full-grown beasts which are being fatted. In the former case much of the nitrogen goes to build up the muscular flesh, and the manure given by young growing animals is proportionately poorer in nitrogen. On the other hand, full-grown animals which are being fatted for market store up chiefly fatty tissue, which contains no nitrogen, and consequently these animals return a larger proportion of nitrogen to the ground. In feeding different species of animals account has to be taken not only of the albuminoid ratio but of what is called the *digestion co-efficient*, or proportion which the food-stuff taken bears to the amount digested.

This proportion is different in the case of different species of animals. In the case of ruminants a large proportion of indigestible fibre in the food is actually necessary.

Sheep cannot assimilate more than half of the 12 per cent. of nitrogenous matter contained in clover hay. Human beings would be able to assimilate scarcely any of the nutriment in hay, the White King, in "Through the Looking-Glass," who took hay when he was faint, being of course an exception to the rule. By submitting the hay to preliminary treatment by an ox or sheep, man is able to assimilate the nitrogen and other nutrients contained in hay in the form of beef or mutton.

To sum up, we may say that nitrogen exists as—

1. *Atmospheric nitrogen*, in which *the atoms of nitrogen are combined with each other*. The bacteria associated with leguminous plants feed upon atmospheric nitrogen.

2. *Ammoniacal nitrogen*, on which plants can, and to some extent do feed. *Here nitrogen is combined with hydrogen.* The source of ammoniacal nitrogen is the decay of animals and plants.

3. *Nitrate nitrogen*, in which *nitrogen is combined with oxygen*. This is the principal form in which plants obtain their nitrogen. Nitrates, generally speaking, are formed by the oxidation of the ammoniacal compounds produced in the decay of animal and vegetable matter. In the presence of alkalies in the soil, such as lime and potash, soluble nitrates are formed which supply both nitrogen and alkali to plants. Nitrate nitrogen is also brought into the soil by the action of electrical discharges in the atmosphere.

4. *Organic nitrogen*, in which the *nitrogen is combined with carbon*. This is the form in which nitrogen is taken by animals, either directly from vegetable food—more particularly from green vegetables—or in flesh-feeding animals, partly as above and partly in the form of lean meat. The organic compounds of nitrogen after the death of the animal or plant furnish the food of the *nitrifying bacteria*, which assist in the work of splitting up these compounds, sending off the carbon as carbonic acid, and leaving the nitrogen, first in combination with hydrogen, and afterwards oxidizing the nitrogen to the form of a nitrate.

Chess Column.

By C. D. Locock, B.A.Oxon.

ALL COMMUNICATIONS for this column should be addressed to the "CHESS EDITOR, *Knowledge Office*," and posted before the 12th of each month.

Solution of Problem No. 1.

Key-move.—1 Q to B2.

If 1. . . . K to K4, or K × P 2. Q to B6ch.
1. . . . R moves, 2. Q × Pch.
1. . . . Kt moves, 2. Q to Q2ch.
1. . . . P × P, or P to B4, 2. Q to QR2ch.

Dual after 1. . . . K to B5, by 2. Q to QR2ch, or Q to QKt2.

Solution of Problem No. 2.

Key-move—1. R to B5.

If 1. . . . P to B6, 2. Kt to B5ch.
1. . . . Kt to B7, 2. R to B4
1. . . . K × Kt, 2. Q × Pch.
1. . . . P to K4, 2. R × BPch.
1. . . . Kt to Q4, 2. Q to K2ch.
1. . . . Anything else, 2. R to K5ch

Dual after 1. . . . P to Kt5, by 2. R. to K5ch or Kt to B5ch.

CORRECT SOLUTIONS received from the following:—

Eight Points.—Kt. J., F. R. Adcock, Rascal, Buttercup, W. T. Hurley, Semper, A. C. Challenger, A. R., B. G. Laws, Guy.

Seven Points.—R. G. Thomson, W. B. Huggitt, W. N., Mogo, Birkenbaum, R. B. Cooke, G. S. Cummings, A Norseman, Chat.

Six Points.—H. S. Brandreth, W. A. Champion, Alpha, Æsculap, Quill, H. Holmes, W. J. Jubb, How's That?, A. E. Whitehouse, J. H. Christie, L. Bourne, Humilis.

Humilis.—The rule about the post-mark is intended to refer to the district in which the letter is posted.

L. Bourne and *H. Holmes.*—By referring to the solutions of the two problems given above, you will see exactly what is meant by a "dual" continuation.

Mogo.—Chess-Editor, *Hackney Mercury*, 10, The Grove, Hackney, N.

W. B. Huggitt.—In that case it is difficult to believe that the problem can have been up to your customary level.

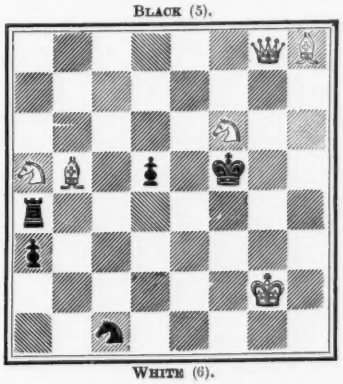
Pearl of the Garden.—The problem has been entered. The post-mark shows that it was posted in time, though it arrived too late to acknowledge last month.

A Norseman.—Could you not avoid some of the misprints which constantly occur in your Chess notation? Unpunctuality condoned for this once only.

POSITION No. 3.

"*Sweetness and purity combined—*
And man contents his lofty mind."

BLACK (5).



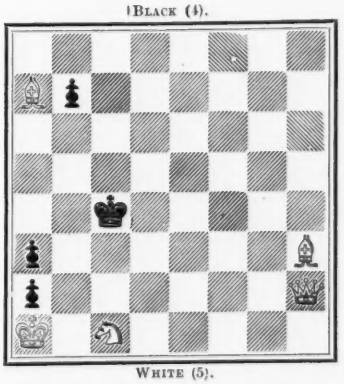
WHITE (6).

White mates in three moves.

POSITION No. 4.

"*Stella.*"

BLACK (4).



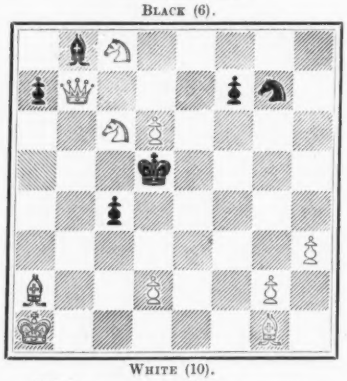
WHITE (5).

White mates in three moves.

POSITION No. 5.

"Bonne bouche."

BLACK (6).



WHITE (10).

White mates in three moves.

NOTE.—In reply to some of our correspondents, the form of solution which we prefer is as follows:—

"No. 1. Q—B2.
Dual after 1. . . . K—B5 by 2. Q—QR2ch.
Q—QKt2.
Remarks."

There should be space for three such solutions on a postcard. Solvers' addresses are registered and need not be repeated.

A triple continuation, should any such occur, will not score more than a dual.

The eighth game of the St. Petersburg match is given as an illustration of M. Tschigorin's novel reply to the French Defence. The idea of 2. Q to K2 is to prevent Black from playing P to Q4.

FRENCH DEFENCE.

WHITE (M. Tschigorin).	BLACK (Dr. Tarrasch).
1. P to K4	1. P to K3
2. Q to K2	2. P to QB4
3. P to KKt3	3. QKt to B3
4. B to Kt2	4. B to K2
5. QKt to B3	5. Q to B2
6. Kt to R3	6. P to QR3
7. Kt to B4	7. Kt to Q5
8. Q to Qsq	8. Kt to KB3
9. P to Q3	9. P to QKt4
10. Castles	10. B to Kt2
11. B to K3	11. QR to Bsq
12. P to QR4	12. P to Kt5
13. Kt to Ktsq	13. P to K4
14. Kt to Q5	14. B × Kt
15. P × B	15. Q to Q3
16. Kt to Q2	16. Q to B2
17. Kt to B4	17. P to KR4
18. P to B4	18. Kt to B4
19. B to Q2	19. P × P
20. B × BP	20. P to Q3
21. Q to K2	21. R to Qsq
22. QR to Ksq	22. K to Bsq
23. P to B3	23. P to R4
24. B to Q2	24. P × P
25. P × P	25. Kt to R3
26. Kt × RP	26. Kt (R3) to Ktsq
27. Kt to B6	27. R to Ksq
28. P to B4	28. Q to Q2
29. B to B4	29. P to R5
30. P to Kt4	30. Kt × KtP
31. B to R3	31. Kt (Ktsq) to B3
32. B to Kt5	32. R to R4
33. QB × Kt	33. P × B
34. Q × Kt	34. Resigns

CHESS INTELLIGENCE.

The match at St. Petersburg between Dr. Tarrasch and M. Tschigorin was finally given up as drawn after each player had won nine games. Four games only were drawn, the players probably preferring to fight their games out to the bitter end rather than play them over again. The German champion was at one time three clear games to the good, but Tschigorin by three consecutive victories soon equalized matters. The performance of the latter player is all the more creditable considering that he seldom got the best of the opening. Dr. Tarrasch, on the other hand, was at his best in the earlier stages of the games. He seemed to lack the patience necessary for a long encounter, and, for the reasons stated above, most of the games were long. He appears also to have been pressed by the time limit on several occasions. Supposing Dr. Tarrasch to have been in his true form, the result of this match effectually disposes of his claims to be considered the equal of Steinitz, who has clearly shown his superiority to Tschigorin whenever he has been willing to adopt rational lines of play.

Evidently the only player who can now be considered to have a chance with Steinitz is E. Lasker, who has added to his already high reputation by his recent bloodless victory in the New York Tournament. Even if his opponents were not of the very highest rank, to score thirteen wins without a single loss or draw can only be regarded as a magnificent performance. The remaining scores in order of merit were:—Albin, 8½; Delmar, Lee and Showalter, 8; Major Hanham, 7½; Pillsbury, 7; Taubenhaus, 6; Pollock, Ryan, and Schmidt, 5; Jasnogrodsky, 4; Olley, 3½; Mr. Gossip bringing up the rear with 2½. It appears that Mr. Schmidt is not Dr. Schmidt of Dresden, as we stated in error last month, but an American-German of the same name and hailing from the same town.

Negotiations are in progress for a match between Steinitz and Lasker, to be played at Havana. They seem, however, to require an excessively large sum for the privilege of playing in that town.

The return match between the North and South of England is now definitely decided on. It will take place in London, probably on April 7th, 1894, and there will be 110 players a side.

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